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AMERICAN WATER WORKS ASSOCIATION

In this issue

Journal

AMERICAN WATER WORKS ASSOCIATION

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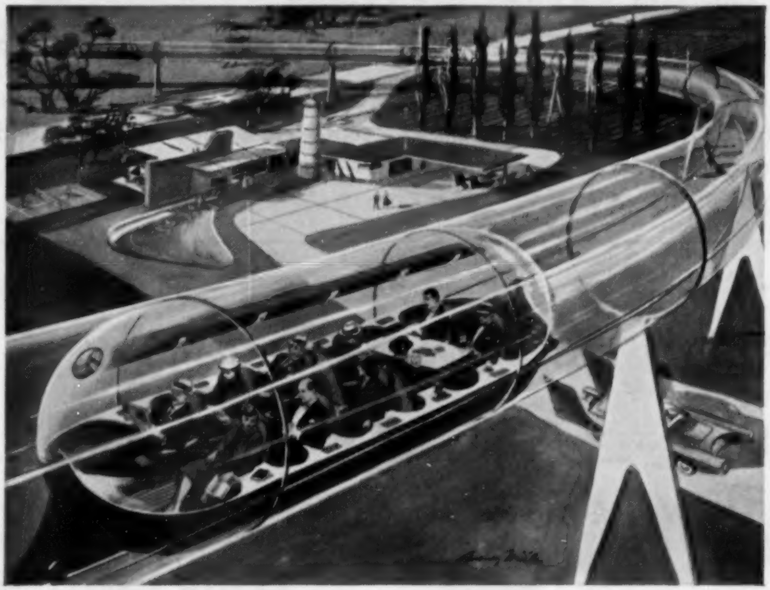

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AWWA DIAMOND JUBILEE CONFERENCE

St. Louis, Mo. May 6-11, 1956

All reservations will be cleared through the AWWA office. The nine official hotels have agreed to accept no reservations for the 1956 Conference except as they are requested on the standard form, through the AWWA.

Coming Meetings

AWWA SECTIONS

1956

Jan. 17—New York Section Midwinter Luncheon, at Park Sheraton Hotel, New York. Secretary, Kimball Blanchard, Rensselaer Valve Co., 11 W. 42nd St., New York 36.

Feb. 8–10—Indiana Section, at Lincoln Hotel, Indianapolis. Secretary, R. J. Becker, Indianapolis Water Co., 113 Monument Circle, Indianapolis 6.

Feb. 14—New Jersey Section Winter Luncheon, at Essex House, Newark. Secretary, C. B. Tygert, Box 178, Newark 1.

Mar. 18–21—Southeastern Section, at Bon Air Hotel, Augusta, Ga. Secretary, N. M. deJarnette, Georgia Dept. of Public Health, 245 State Office Bldg., Atlanta 3.

Mar. 21–23—Illinois Section, at LaSalle Hotel, Chicago. Secretary, D. W. Johnson, Cast Iron Pipe Research Assn., 122 S. Michigan Ave., Chicago 3.

Apr. 3–5—Pennsylvania Section, at Bellevue-Stratford Hotel, Philadelphia. Secretary, L. S. Morgan, State Dept. of Health, Greensburg.

Apr. 4–6—Kansas Section, at Jayhawk Hotel, Topeka. Secretary, H. W. Badley, Neptune Meter Co., 119 W. Cloud St., Salina.

Apr. 5–7—Arizona Section, at Safford. Secretary, Quentin M. Mees, Arizona Sewage & Water Works Assn., 721 N. Olsen Ave., Tucson.

Apr. 6–7—Montana Section, at Livingston Murray Hotel, Livingston. Secretary, A. W. Clarkson, State Board of Health, Helena.

(*Continued on page 8*)

Coming Meetings

(Continued from page 6)

Apr. 11–13—Nebraska Section, at Cornhusker Hotel, Lincoln. Secretary, J. E. Olsson, Fulton & Cramer, 922 Trust Bldg., Lincoln.

OTHER ORGANIZATIONS

1956

Feb. 13–18—Symposium on Winter Concreting Theory and Practice, International Union of Testing & Research Labs. for Materials & Structures (RILEM), Copenhagen, Denmark. Organizing Secy., RILEM Symposium 1956, c/o Danish National Inst. of Building Research, 20 Borgergade, Copenhagen, K, Denmark.

Jun. 17–23—World Power Conference, Vienna, Austria. Oesterreichisches Nationalkomitee der Weltkraftkonferenz, Vienna I, Schwarzenbergplatz 1.

Nuclear Engineering and Science Congress Cleveland, Ohio, Dec. 12–16, 1955

The Congress, to be held at Cleveland's Public Auditorium, is sponsored by Engineers Joint Council, with AWWA and other organizations cooperating. An International Atomic Exposition, sponsored by American Institute of Chemical Engineers, will also be held at the Public Auditorium, Dec. 10–16. AWWA-sponsored papers to be presented at the Congress on Thursday and Friday, Dec. 15 and 16, are listed below:

Instrumentation for Radioactive Pollution Studies—A Survey by AWWA Task Group 2630 P........ HAROLD E. PEARSON

Use of Portable Instruments for Detection and Monitoring of Emergency Levels of Radioactivity in Waters........ SIMON KINSMAN

Measurements of Radioactivity in Water........ L. R. SETTER & A. S. GOLDIN

Radiochemical Techniques for Separation of Radioisotopes........ BERND KAHN

Removal of Radionuclides From Water by Water Treatment Processes........ ROY J. MORTON & CONRAD P. STRAUB

Mixed-Bed Ion Exchange for the Removal of Radioactivity........ H. GLADYS SWOPE

Processing of High-Level Atomic Wastes With a View to Ultimate Disposal........ L. P. HATCH & W. H. REGAN JR.

Decontamination of Radioactive Water Supplies... ROLF ELIASSEN & ROBERT A. LAUDERDALE

Ultimate Disposal of Radioactive Reactor Wastes in the Oceans........ CHARLES E. RENN

Status of Soil Disposal for Reactor Wastes........ ARNOLD B. JOSEPH

Long-Range Fallout in Surface Water Supplies........ C. G. BELL JR.

Maximum Permissible Levels of Radionuclides in Air and Water........ K. Z. MORGAN

AEC Fallout Monitoring Network........ MERRIL EISENBUD

Emergency Maximum Permissible Concentration Values in Water........ CONRAD P. STRAUB

Biological Methods for the Removal of Radioactivity From Liquids.... WILLIAM E. DOBBINS

complete process instrumentation

F&P Chlorinator Proven Under Severe Test by City of Columbus

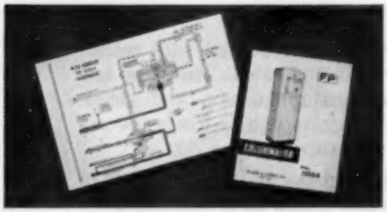
Freedom from corrosion, low maintenance and operating costs induce city officials to acclaim its virtues

Willard Harper, Chief Chemist, adjusts the setting on a Ratochlor unit.

Faced with the need of replacing its obsolete chlorinator, the City of Columbus, Ohio, tested an F&P chlorinator for 8 months under the most adverse conditions. So pleased were Marshall Houghn, chief of the Dublin Road plant, Willard Harper, Chief Chemist, Paul C. Laux, Water Division superintendent, and Floyd C. Redick, Public Service Director, with its performance that two new Fischer & Porter Chlorinators and an Evaporator were installed. The Dublin plant keeps one chlorinator in constant operation and the other for reserve purposes.

Here are the features of the F&P Model 1050-A Chlorinator—

- Only materials completely inert to corrosion are used in construction
- Cabinet made of plastic-impregnated Fiberglas—never needs painting
- Simplicity of operation—internal piping in vacuum system employs "snap-in" type construction with "O" rings requiring no unions
- Designed for installation by unskilled labor



Flow diagram shows the simplicity of the Fischer & Porter Model 1050-A Chlorinator. This 6-page folder gives additional information. Send for your free copy today.

Fischer & Porter offers a wide variety of chlorinators for use in municipal water systems, industrial plants, swimming pools. Consult your local F&P representative or write for free literature.

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High-quality, low-cost WELDED STEEL PIPE *for more efficient water supply lines*

When planning your next permanent water supply project, be sure to consider the quality and money-saving features of American's welded steel pipe. Many cities throughout the Northwest have found it to be the answer to their problems . . . and orders and *re-orders* now total over 400,000 feet.

Manufactured to buyer's specifications in accordance with A.W.W.A. standards, it is available in 12" to 144" diameters in nominal lengths of 40 feet with plate thicknesses ranging from 3/16" to 1½". Coal tar enamel lining and coating (asbestos felt wrapping where required) protects against corrosion. The pipe is fabricated with one longitudinal tension seam only on *all* diameters. Longitudinal and girth seams are automatically welded.

This outstanding pipe can be advantageous to you in initial economy and trouble-free performance. We'd like to plan with you on your next project . . . our services include both manufacture and installation where desired. Call us for estimates and further information.

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AND CUTS SOFTENING COSTS

When population jumped to 6,800, East Aurora increased pumpage by 72% from 320,000 to 550,000 gpd. Even at this increased volume, they cut salt costs $4000 a year! They also ended a red-water problem by reducing iron from 1.3 ppm to 0. And they use the *same manpower!*

HOW WAS IT DONE? The increased volume and salt savings were accomplished by using Permutit Q, a high-capacity ion exchange resin with low salt consumption. The iron problem was solved with two Permutit filters. Manpower was not increased because the automatic hardness testers eliminated manual testing. And the efficiency of Permutit's automatic multiport valves frees the operators for other plant duties.

WHY PERMUTIT? "We started with Permutit equipment in 1935, and it worked out so well that we called on Permutit again for our 1950 expansion," says Village Engineer E. J. Maurer.

Permutit will work with you to modernize your present plant or to plan a new one. Call us early in the planning so we can be of most help. The Permutit Company, Dept. JA-12, 330 West 42nd Street, New York 36, N. Y.

A 51% increase in population caused East Aurora, N. Y. to expand and modernize its water works. Wooden structure (left) was replaced by a modern brick building which contains the latest in water conditioning equipment.

PERMUTIT®

WATER CONDITIONING

Equipment • Resins • Experience

EVERDUR STEMS:

TURN THEM EASILY—ONCE A DAY OR ONCE A YEAR. THEY RESIST CORROSION.

Rust and efficiency—like oil and water—don't mix. In gate and valve stems rust costs money. You avoid this by specifying stems made of Everdur*—*strong, rustproof and corrosion-resistant.*

Everdur Copper-Silicon Alloys have long been fabricated into lightweight sewage and waterworks structures. Gates, screens, guides and bolts, weirs, float chambers, troughs, manhole steps and electrical conduit—all gain *extra* protection when made of Everdur.

Depending on the type or composition, you can work Everdur Alloys hot or cold, and readily form, forge, weld and machine them. They are available in plates, sheets, rods, tubes, electrical conduit and casting ingots.

Write for free booklet, "Everdur Copper-Silicon Alloys for Sewage and Waterworks Equipment." For practical advice on selecting the correct material for your equipment, consult our Technical Department. Their services are freely available. *The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

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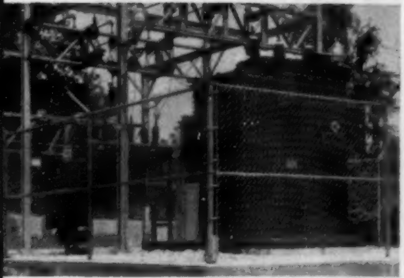
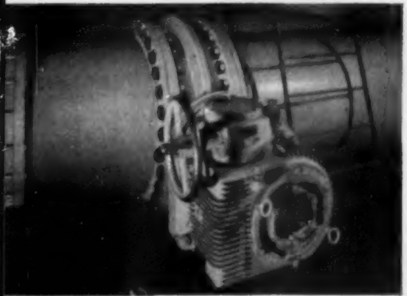
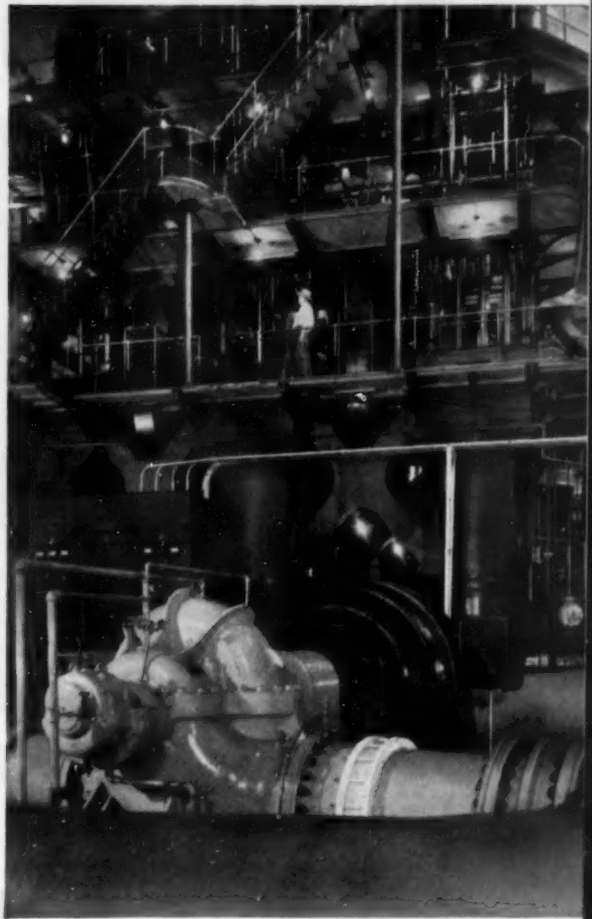
Modernize and Expand Water Works



Allis-Chalmers outdoor substation protects and controls electrical power supply for the City of Milwaukee's Riverside pumping station.





Close-up showing one of several of the latest Allis-Chalmers butterfly valves installed at the Riverside station. A-C builds many designs of valves, including units conforming to American Water Works Standards.

Two new Allis-Chalmers 30-mgd pumps and their 2000-hp synchronous motors and controls were fitted into the space formerly occupied by a single 30-year-old, 15-mgd pumping engine.

This view of Riverside station installation dramatizes progress in pump design in the past 30 years. Towering pumping engine in background was record setter in 1924 and is still going strong. But at best it pumps only two-thirds of the water handled by compact new Allis-Chalmers pump in foreground.

CHALMERS A-C ALLIS-CHALMERS

Builders of World's Widest Range of Public Works Equipment

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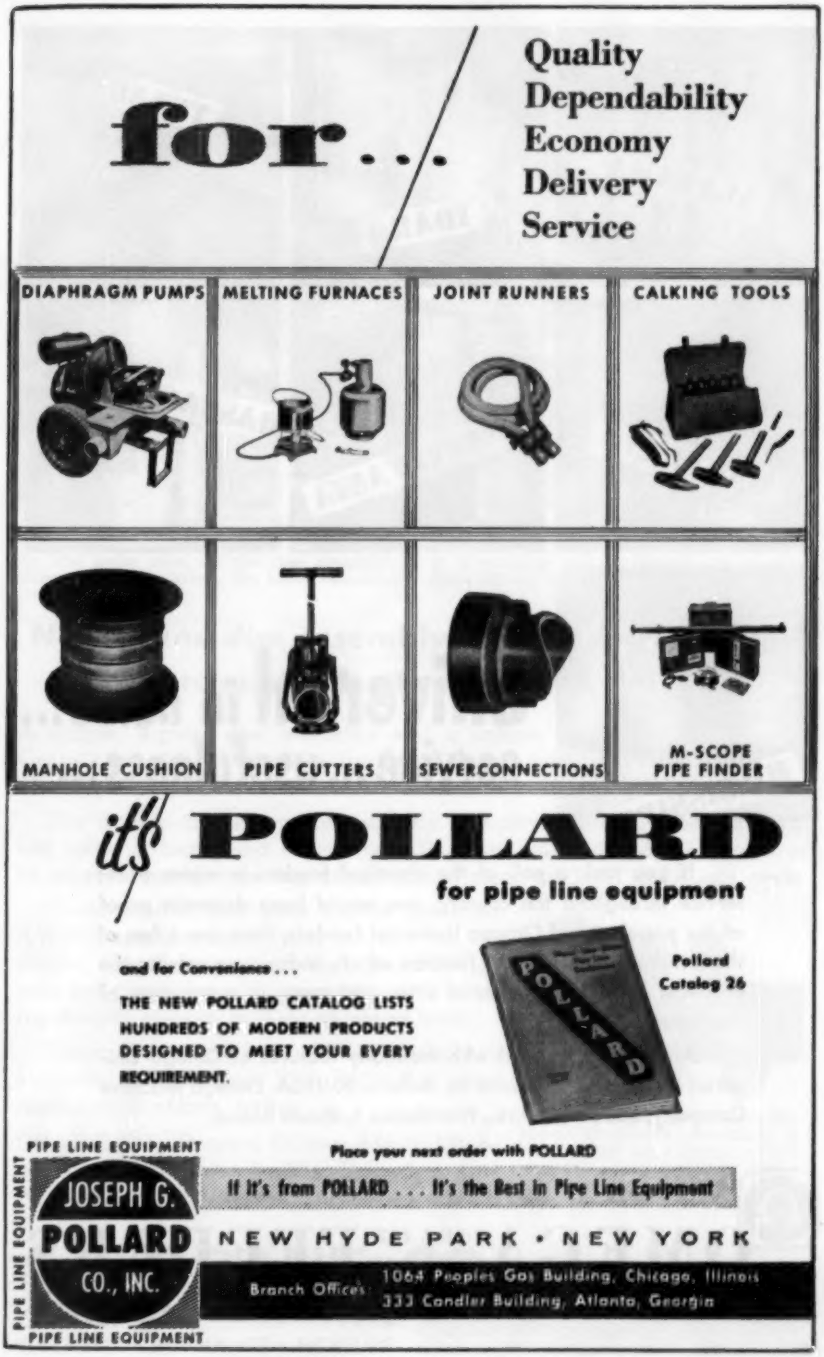
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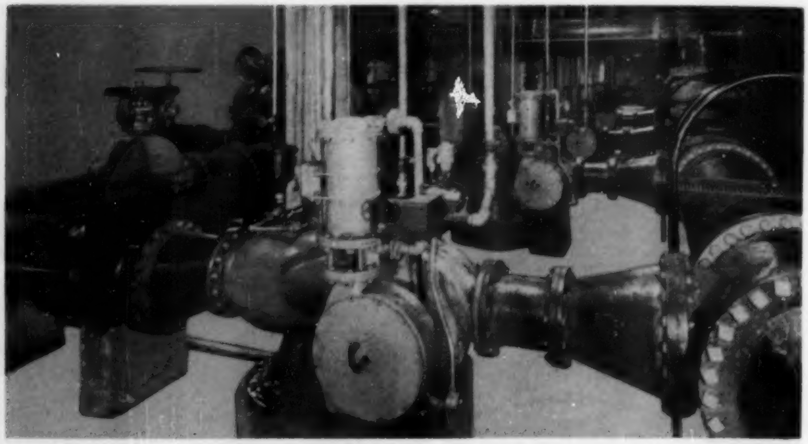

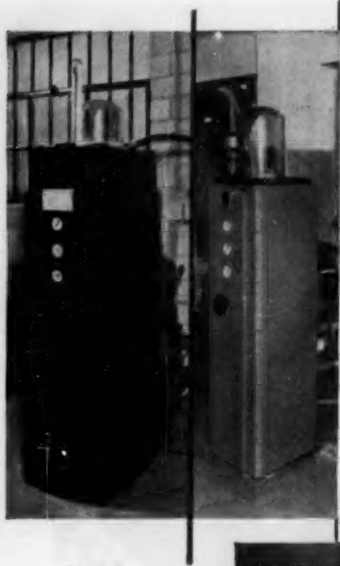

City Water Board
San Antonio, Texas

February 11, 1955

Mr. Fred Puckhaber, Division Manager
Wallace & Tiernan, Incorporated
National City Building
Dallas, Texas

Dear Mr. Puckhaber:

Relative to your inquiry, we are pleased to advise you that the Series A-421 water diaphragm vacuum type chlorinator, recently installed for chlorination of both infeed and outfeed water at our 2,300,000-gallon Inspiration Reservoir, is operating most satisfactorily. Sample tests taken daily over a one week period establish almost a uniform chlorine residual 0.17 ppm throughout all areas of the reservoir and a 0.24 ppm residual within the outflow at sampling points four and five blocks distant from the reservoir. The foregoing is precisely the result outlined to be accomplished and we are indebted to you and Jim Morgan of your Houston office in the realization of the desired goal.

Our Mr. R. H. Martin, maintenance mechanic of the Production Department, two years ago assumed supervision of the operation and maintenance of some seventeen of your Type A-418 water diaphragm vacuum type chlorinators installed at primary and auxiliary pump stations. At that time a servicing program was initiated whereby principal gaskets and regulation diaphragms and springs are renewed periodically, and we are very happy to report that subsequently all machines have been operating continuously at a surprisingly low maintenance cost. Our first two machines were purchased in 1942 with additional units having been added as system expansion developed. Our experience indicates that the A-418 machine is of Spartan simplicity in construction, but fully equipped to adequately and reliably accomplish its function within the designed limits.

Very truly yours,

R. A. Thompson, Jr.
General Manager

"...LOW MAINTENANCE COST..."

with water diaphragm chlorinators

San Antonio, Texas, has eighteen W&T water diaphragm chlorinators in use on its water sytsem. The first units were purchased in 1942.

Mr. R. A. Thompson, Jr., General Manager for the City Water Board reports "... all machines have been operating continuously at a surprisingly low maintenance cost. Our experience indicates that the A-418 machine is of Spartan simplicity in construction, but fully equipped to adequately and reliably accomplish its function ..."

When you buy W&T equipment, you have reliability, simplicity and adequacy built in. These qualities are the result of 40 years of experience in the chlorination field.

"Make Your First Choice Equipment That Lasts."

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Journal
AMERICAN WATER WORKS ASSOCIATION
VOL. 47 • DECEMBER 1955 • NO. 12

Atomic Energy and the American Economy

Nelson P. Jackson

An address presented on Jun. 15, 1955, at the Annual Conference, Chicago, Ill., by Nelson P. Jackson, Mgr., Washington Office, Atomic Products Div., General Electric Co., Washington, D.C.

AMONG the realities which the people of the US must face, two stand out very sharply. The first is that, at the present growth rate (with the number of births reaching 4,000,000 in the year 1954), the population of the country will exceed 200,000,000 by 1975. Directly related to the population growth is the very salient fact that by 1975 the need for electric energy will approximate three times the 1955 kilowatt hour consumption.

Against this backdrop let us face the question: "Where does atomic energy fit into the economic structure as we know it today and as we project it into the next two decades?" It is no accident that the US, with only 7 per cent of the world's population, produces 50 per cent of the world's manufactured goods. More than any other reason, the abundant energy derived from fuel laid down in the storehouse of prehistoric eras is a very fundamental factor. This country, as well as a considerable portion of the free world, has been living high on the accumulated capital of energy embedded in the tremendous reserves of coal, oil, and gas. The rate of extraction of these unrenewable fossil fuels has been unbelievable. If we are to continue our standard of living, it is essential that new sources of energy be developed, and our surest hope lies in the field of nuclear fuels. Although we can be sure that there will be important applications of nuclear energy for transportation, heating, and many industrial processes, there is little or no question that the greatest application will be in the production of electric power.

The General Electric Co., with which I have the honor to be associated, has been distinguished for many years because of the high level of its scientific personnel. In the fields of physics and related engineering, General Electric scientists have been leaders. General Electric physicists were studying atomic fission in the 1930's. The company furnished men, machinery, and equipment to the Manhattan

District planners and for the construction and development both at Oak Ridge, Tenn., and Hanford, Wash. The operations at Hanford, as well as the Knolls Atomic Power Laboratory in Schenectady, N.Y., have been, and continue to be, operated by the General Electric Co. During the year 1955, both at the International Conference on Atomic Energy in Geneva and at the Nuclear Engineering and Science Conference held in December in Cleveland, General Electric personnel were participants in the discussion and exhibits of General Electric developments.

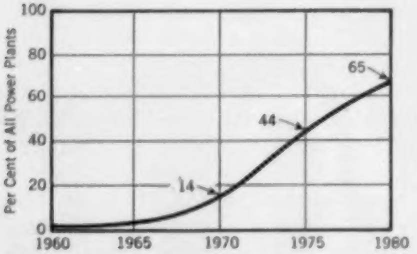

Fig. 1. Predicted Growth in Number of New Nuclear Plants

Nuclear energy will be used for transportation, heating, and industrial process, but the greatest application will be in the production of electric power.

By 1975 it is estimated that nearly one-half of the power stations then under construction will use nuclear fuels. The projected growth of nuclear plants is shown in Fig. 1, starting at about 2 per cent between 1960 and 1965, and growing to 14 per cent by 1970 and 44 per cent by 1975. It would not be surprising to see this figure reach 65 per cent by 1980.

Present Power Plants

Now, what is going to happen to conventional power plants using fossil fuels? Some may assume that, with the advent of nuclear fuel, coal and oil will be forced out of the picture. Nothing could be farther from the truth, however, as shown in Fig. 2. While we are confident that nuclear energy will show phenomenal growth during the next 25 years, many million kilowatts of new capacity of fossil-fueled stations will be required to support the growth of our economy during that period.

Here are the forecast totals of generating capability in the US. In terms of total generating capacity, the growth of nuclear power stations will, of ne-

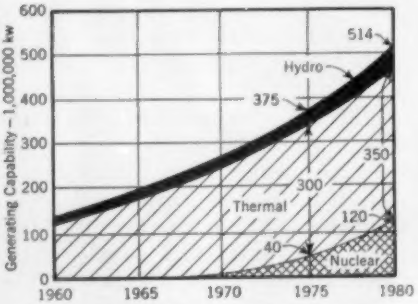

Fig. 2. Predicted Total Generating Capability of Power Plants

The increase in nuclear-power production is accompanied by increases in hydro- and thermal-power production. Top of hydro-power area represents total generating capability of all plants.

cessity, start slowly. In order to care for the power needs of our country, it will be necessary that the conventionally fueled generating capacity be increased from 120,000,000 kw in 1960 to 300,000,000 kw by 1975 and 350,000,000 kw in 1980.

The three points of cardinal importance illustrated by the three figures are: first, that the future power needs of our country are phenomenal; sec-

ond, that the greatest growth in generating capacity in the next 25 years will still lie in fossil fuel plants; and third, that, in this same 25-year period, the construction of new nuclear fuel power stations is forecast to equal the total generating capacity which has been installed in our country up to the year 1955.

Costs

Now let us look at the investment figures shown in Table 1. Start by comparing plant investment for a representative coal-fired plant and the figures for a boiling-water reactor which we believe can be achieved within the next 5–10 years. It will be noted that the investment in physical plant is substantially larger for the nuclear station and that, similarly, the engineering and start-up charges are greater. This brings to us the fact that nuclear power plants require greater financial investment, and, therefore, call for a greater contribution of investment dollars than do coal- or oil-fired plants.

TABLE 1

Comparative Investment Costs of Nuclear Plant and Coal Plant

Item	Cost—$/*kw*	
	Boiling-Water Reactor Plant	Coal Plant
Physical plant	195	140
Engineering	15	11
Start up	14	7
Land	2	2
Total	226	160

The *payoff* lies in power costs. In Table 2 we see that the fixed charges of a nuclear plant are, as we would expect, approximately 50 per cent greater than those of a coal plant. Similarly, operating costs are 0.2 mill greater per kilowatt hour. The real saving lies in fuel costs. For the coal plant, we have shown costs which are not yet obtainable but which we are fully confident can be realized and will be bettered.

The cost situation is summarized and illustrated by Fig. 3. Today's nuclear reactor costs are not competitive with conventional steam plants in the heavily populated centers of this country, but, with plant investment costs which can be foreseen and with lower nuclear fuel costs which we are on the way toward developing, costs of electric power generated from nuclear energy can and will be fully competitive with costs of power from conventional steam stations. Because the supplies of fossil fuels will be sorely strained in the next 25 years, we cannot expect those fuels to become lower in cost. Nuclear fuel development is in its infancy. We have every confidence that the fuel costs shown here will be met or bettered. So much for the economics of atomic electric power.

TABLE 2

Comparative Power Costs of 300,000-kw Boiling-Water Reactor Plant and Coal Plant

Item	Cost—*mills/kwhr*	
	Boiling-Water Reactor Plant	Coal Plant
Fixed charges	4.5	3.0
Operating costs	0.7	0.5
Fuel	1.7	3.4*
Total	6.9	6.9

* Coal at 35¢ per 1,000,000 Btu.

Water Treatment

Now let us consider water treatment and waste disposal in atomic energy work. Most of the water used for reactor cooling at Hanford comes from the Columbia River. To treat and supply the tens of thousands of gallons per minute needed for the reactors, Hanford operates one of the world's largest water systems. All of the water used for reactor cooling is subjected to a complete rapid-sand filtration process.

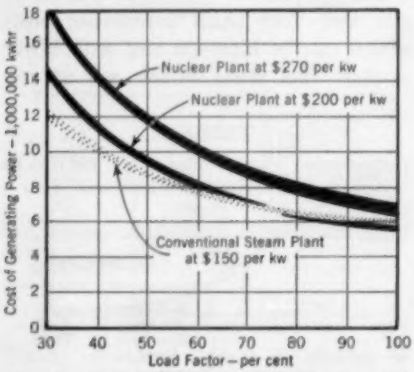

Fig. 3. Costs of Power From Nuclear and Conventional Plants

At present, nuclear plants cannot compete with conventional plants because of very high plant costs. With new nuclear fuels estimated at 1.5–2.0 mills per kilowatthour in the future, however, costs of power from nuclear and conventional plants will be completely competitive.

As is the case with most water treatment plants, demands at Hanford have outstripped the design capacity. However, by adopting ultramodern high rates of filtration (4–6 gpm per sq ft) it has been possible to meet the increased demands.

The characteristics of the Columbia River make high-rate filtration more practical at Hanford than at most locations. The turbidity of the water rarely exceeds 500 ppm even during flood stage, while the average annual value is 10 ppm or less. The temperature of the water varies from 0°C to 20°C during the year.

One of the unusual characteristics of the river water is the uniformity of its composition. The hardness, for example, rarely changes more than ±5 ppm during the year, and the pH, alkalinity, sulfates, and chlorides exhibit relatively minor seasonal changes. The problem of coping with algae or other forms of water life is a minor one, probably because the water is cold and contains little nitrogen or phosphorus.

Chemical treatment costs at Hanford are relatively low, even though alum costs about $52 a ton, and sodium silicate costs about $37.50 a ton delivered. The high cost of chemicals results primarily from high freight charges. The nearest source of dry alum is the San Francisco area, almost 1,000 miles from the project. The silicate source is closer, but is still 300 miles away.

The water treatment chemical costs average about $3 per million gallons, including alum, activated silica, chlorine, and lime. Considering the very high quality of the filtered water and the high unit cost of chemical, it is believed that an unusually good job is being done costwise in water treatment at Hanford.

In an effort to seek water treatment methods that will permit greater production of plutonium at Hanford, a new $1,500,000 laboratory is now in operation. The goal is to find economical ways of chemically treating the water for cooling the reactors operating at higher power than at present. Water flow through a reactor area is shown in Fig. 4.

In operating the Hanford project, General Electric scientists and engineers have found that, as reactor power

increases, so does corrosion of reactor tubes and slugs. Research is needed to determine methods of decreasing this corrosion by continued improvement of cooling-water treatment techniques. In addition, impurities in the cooling water become radioactive when exposed to intense neutron bombardment in the reactors. A conservative limit has been set on this radioactivity so that the effluent will not damage aquatic life in the Columbia River.

The new laboratory will be in operation 24 hours a day. It will provide large-scale facilities for experiments in filtering and chemical treatment, and for pumping water through simulated hydraulic systems and test channels in a nearby reactor.

Equipment for corrosion and hydraulic studies is also included in the laboratory facilities, as are indoor and outdoor fish troughs and ponds where aquatic life can be exposed to various concentrations and types of reactor effluent.

The study of Columbia River aquatic life, both above and below the Hanford reactors, is nothing new, however. Since the river water below Hanford is used for sanitary water supply, irrigation, navigation, hydroelectric power, fish and wildlife, and recreation, aquatic biologists at Hanford carry out a carefully designed program to insure that the reactor effluents returned to the river are not producing a health hazard.

In its passage through the reactors, the process water becomes radioactive due to the neutron bombardment it receives. Most of the radioisotopes which are formed have rapid decay rates and are produced from the original dissolved solids in the water or corrosion products from the metals contacted by the water.

Large retention basins have been provided to hold this water for a period of time before its return to the river. This process step allows for appreciable radioactive decay. After remaining in the basins for a certain length of time, the cooling water and its limited concentration of radioisotopes is discharged into, and mixed with, the main body of the river. As the mixture flows down the river there is more decay of radioactivity, and by the time of arrival at Richland, the government-owned city that serves Hanford, the effluent water is essentially uniformly diluted with the river water (*see* Fig. 5). With additional dilution by the Yakima, Snake, and Walla Walla Rivers, the radioisotope concentration is further reduced. The concentration is very important from a public health point of view, and it is kept below the maximum permissible concentrations.

Many water samples are taken of reactor-cooling waters and of the Columbia River. The activity density of alpha and beta particle emitters and certain specific radioisotopes are determined. Samples of the water are collected on a daily to weekly basis at representative locations between the reactor areas and McNary Dam, which is about 46 miles downstream from Richland. From McNary Dam to Portland, Ore., a distance of approximately 193 river miles, samples are collected on a monthly basis. Special attention is given to the Columbia River water supply of Pasco and Kennwick, Wash., two communities just nine miles downstream from Richland.

In conjunction with the foregoing monitoring studies, the effect of radioactivity on the ecology of the river is also observed, especially the effect on the aquatic life. Although detectable

amounts of radioactivity occur in the water of the river below the reactors, no health hazard to users currently exists. The amount of radioactive material deposited in the fish of the river is likewise low in comparison to accepted standards.

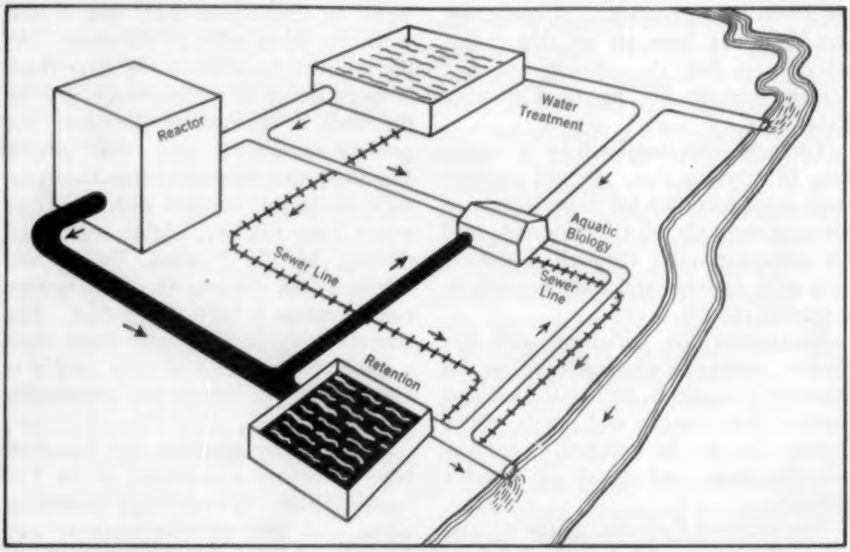

Fig. 4. Water Flow Through Hypothetical Reactor Area

Impurities in cooling water become radioactive when exposed to neutron bombardment in the reactors. A conservative limit has been placed on this radioactivity at Hanford so that aquatic life in the river will not be affected.

Disposal

Turning to the problem of disposal, there are three types of disposal to deal with at Hanford. These are gaseous-waste disposal, solid-waste disposal, and liquid-waste disposal.

The unusual problem facing the engineer in design of contaminated-air disposal facilities is that, by ordinary considerations of weight and concentrations of material in the air stream, the air is quite clean, and, yet, from a radiation hazard viewpoint, dangerous concentrations of radioactive gases, mists, and dusts may exist. Airborne material of the larger particle sizes may be successfully removed by mechanical separators and industrial filters, but, unfortunately, the efficiency of the conventional equipment falls off rapidly with reduced particle sizes, and a small particle may more readily reach the lung than a large particle. Adequate decontamination of such air streams has required the development of filtration media of vastly improved efficiency or the use of chemical scrubbing equipment.

An atomic-energy installation produces a wide assortment of wastes in the form of radioactive solids. Also, many solid materials become contaminated with radioactive liquids and dusts. Such items include any which

have been exposed to neutron bombardment in the piles, all types of industrial equipment contacted by radioactive liquids in the separation processes, and building surfaces which have been contaminated by radioactive materials.

Combustible wastes which have become radioactive or contaminated may be reduced in volume by incineration in closed-cycle systems. But the most common method employed at some installations for disposal of all types of solid wastes is simple burial in the ground. This is considered a temporary measure at best, and can be tolerated only at sites where permanent control of the burial location is assured. Also there must be little chance that the material will leach out and progress downward to ground water, from the action of natural precipitation.

A more acceptable method is to cast contaminated items into concrete before burial, or to provide concrete underground storage vaults to receive larger pieces of equipment. In any case, continued control of the burial location should be provided for a period of time as required by the decay rates of the radioactive elements present, and, in some cases, this means many years.

In liquid-waste disposal, as in gaseous-waste disposal, the quantities of radioactive material present may be very small by ordinary considerations of liquid contaminants, but they are of extreme significance from the radiation hazard viewpoint. An example would be strontium 90, where one part of strontium in 20 quadrillion (2×10^{16}) parts of water by weight is equivalent to the permissible limit for drinking water.

Appropriate planning for safe disposal of liquids contaminated with radioactive material depends on the magnitude of each individual problem. At hospitals or small laboratories which use radioisotopes for therapy or experimental work, the volumes involved are usually small, and in most cases the decay rate of the material is rapid.

In such cases it may be expedient to retain the liquids until the radiation has decayed to an insignificant level.

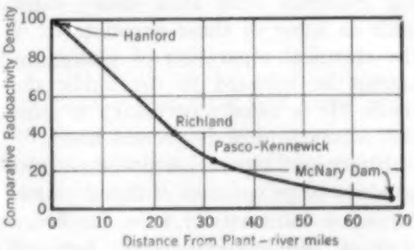

Fig. 5. Diminishing Radioactivity Content With Distance Downstream

By the time the water reaches Richland it is essentially uniformly diluted with river water.

In the case of isotopes with slow decay rates, it may be found feasible to include the liquid in a concrete mixture, and then dispose of the block by burial or by dumping at sea.

Use of the principle of isotopic dilution may also be economical when the waste volumes are small. Since living organisms select nonradioactive isotopes of a chemical element in preference to the radioactive forms, dilution of the radioactive material with proper quantities of stable isotopes of the same elements prior to release may provide a ready method of effecting safe disposal.

Where liquids are released to the environs, either with or without isotopic dilution, it must be determined whether organisms exposed to the waste concentrate the radioactive mate-

rial to any degree. For example, phosphorus 32 in water may be concentrated in aquatic life by a factor as high as 500,000. Such concentration factors must be considered in determining the safe release limit.

In installations where volumes of radioactive liquid waste are large, safe disposal methods can easily become of great economic importance. In general, highly radioactive liquids containing elements with slow decay rates, such as some of those encountered in the chemical separation of plutonium, cannot be released to the public domain. It is usually necessary to store this material in underground tanks.

Plutonium separation processes also produce large volumes of liquid wastes having a radioactivity level far below that of the stored wastes, but still above the permissible limits for drinking water. If the chemical separation plants are sufficiently remote from drinking water sources, it is possible to release these low level wastes below the ground surface through open lattices and tile fields. At Hanford, the percolation of such wastes into the ground has been safe because of the nature of the subsoils.

These soils adsorb much of the radioactive material, so that the liquids reaching the ground water are significantly decontaminated. The slow movement of the radioactive material in the ground water is carefully followed by means of test wells, and geologists estimate that present practices may continue for many years without creating a public hazard.

A recent development at Hanford is a method of scavenging which is used to reduce the volume of liquid waste from one plant. In this method, suitable chemicals are added to the process waste streams, so that a precipitate will be formed. This precipitate removes certain long-lived radioisotopes from the solution and carries them down into a sludge at the bottom of a tank. This leaves a solution that can be pumped into dry wells for ground disposal. The process is carried on at a substantially lower cost than previous methods and permits a tenfold reduction in the total volume of required storage-tank space.

Improvement in container design at Hanford has also resulted in considerable cost reduction. The underground tanks are constructed of conventional reinforced concrete with a liquid-tight steel plate liner. Tank capacity was made one-third larger by increasing the height, thereby reducing the number of costly dome roofs and the amount of excavation.

Evaluations of two phenomena effected savings. First, specific gravity of liquid waste is at its lowest when the tank is first filled, and gradually increases during a self-evaporation process. Second, high initial stresses in concrete, caused by its shrinkage during curing, are dissipated in time by plastic flow of concrete. The combination of these natural events, make it unnecessary to allow for the shrinkage stresses in the concrete at the time the tank contains the heaviest liquid. A design developed on this basis resulted in a maximum wall thickness of 24 in. less than the thickness previously thought necessary. On recent tank farms, these findings brought about a cost reduction approximating 5½ cents per gallon of capacity, resulting in a saving of over $900,000.

Many times the adequate solution of one waste disposal problem may present another. A chemical scrubbing system to clean exhaust air develops a radioactive liquid which may require

further treatment before release. The distillation apparatus for volume reduction of a liquid-waste stream produces a condensate which must meet permissible limits before disposal to the ground.

The successful use of atomic energy and radioactive materials as standard industrial and scientific tools may be developed only if the resulting waste products produce no hazard to the surrounding community of vegetation, animals, and men. The complete realization of this objective requires much additional research and development work for better methods of waste disposal.

In the field of liquid-waste disposal research, progress is based on several principles. One is that we must realize that waste disposal problems may be a limiting factor in the full usage of atomic energy. A second is that potential waste disposal difficulties should be considered at all stages in the research and design of processes and experimental facilities. A third principle is that, whenever possible, standard industrial equipment should be adopted in establishing waste disposal treatment facilities. A fourth is that extensive dilution in a disposal process should be used only if it yields highly decontaminated effluent not otherwise attainable. And a fifth principle is that permissible limits must be realistic and based on experimental evidence. However, the general goal should be to reduce the radioactivity of the material released to natural background levels.

It can probably be said that no new industry has given such serious consideration to its waste disposal problems in the interest of public welfare as has the atomic energy industry. Solutions to its problems were sought and found before any significant problems to the public were caused. All of us involved in radioactive-waste disposal problems, both now and in the future, must assist in preserving this enviable record.

Conclusion

A closing thought I will leave with you summarizes, in my opinion, the present situation in nuclear energy. You may recall that in the fourth act of *Julius Caesar*, Cassius advocates a course of "rest, defense, and nimbleness." Brutus replies:

There is a tide in the affairs of men,
Which, taken at the flood, leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat;
And we must take the current when it serves,
Or lose our ventures.

The nuclear tide is nearing its flood. Men of courage and conviction in science, in industry, and in finance are faced with opportunities unequalled in our business lives. This new field of atomic energy has been, is now, and will continue to be a challenge to America's research, engineering, and manufacturing skill.

Design Criteria for Distribution Systems

H. E. Butler

A paper presented on Apr. 15, 1955, at the California Section Regional Meeting, Riverside, Calif., by H. E. Butler, Sr. Water Engr., Glendale, Calif.

THE dictionary defines the word *criteria* as meaning "data and facts upon which good judgment can be based." Certainly all water works operators have available to them abundant data and facts pertinent to water use within the area they are serving, but because of the lack of enforceable minimum standards, good judgment is frequently superseded by substandard planning made necessary by a financial deficiency. This paper will not deal with the financing of water distribution systems, but will review the need for establishing a standard for customer service and the data and facts necessary for designing a distribution system to provide that service. These data and facts will represent an average of various use factors obtained by a recent survey of water works in California.

Standards for the quality of water supplied by a utility have been established by federal and state specification. Standards of quantity are usually established by the capacity of the pipelines transporting the water to the customer. The means of distribution should be of a sufficient capacity to supply the customer demand at all times. Service which fails in this requirement is less than adequate and the result is customer dissatisfaction. The only remedy for this is the replacement of the inadequate distribution facilities. Such replacements are a public inconvenience and are usually difficult to finance, but if they result in a standard of ideal service and if proper design criteria is utilized, ultimate savings and satisfied customers will be insured.

Satisfactory Supply

Before adequate design criteria can be established, it is necessary to define the objective. Regarding the quantity of water supplied, Sec. 5.2 of the California Water Supply Standards (*1*), adopted by the California Section in October 1948, states: "The quantity of water delivered to the distribution system from all source facilities should be sufficient to supply adequately, dependably, and safely the total water requirements of all consumers under maximum consumption." Based upon such a standard of quantity, the design criteria must be of maximum demand units projected through the planning of the entire ultimate area to be served.

Topography, zoning, location of source, customer use, and fire supply must all be considered as basic data in the design of the water distribution system. All water works operators have been faced with the need to increase the size of supply mains because of expansion into areas and elevations not adequately considered at the time of initial installation. Topog-

raphy of the entire potential area should be carefully studied for the purposes of determining reservoir locations, service zones as related to minimum and maximum static pressures at customer premises, and future service to areas beyond immediate consideration. Zoning plans should be critically explored as to the location of residential, business, and industrial areas, and the possible rezoning of areas that may change the type of service required. Good judgment at this point may sometimes carry beyond the point of economic feasibility, but unless the planning of utility expansion is reasonably in advance of property development, the problem of deficient facilities will inevitably arise.

Customer Use

Customer use must be determined in terms of both maximum demand in gallons per minute and gallons per capita per day, and it must be assumed that customer service and house lines from the main to point of use will average approximately 75 per cent of capacity efficiency throughout normal life. House lines and plumbing on customer premises have proved to be the major causes for customer complaints of poor supply and pressure loss. Thus, in order to maintain the standards of quality for which the system was designed, a program for replacing inferior service lines from the main to customer premises and for advising the customer of the condition of house lines is desirable.

In a first class residential area, maximum demand per customer will range from as little as 6 gpm, for small home sites without yard sprinkler systems, to more than 70 gpm, for larger home sites with yard sprinkler systems throughout the entire exterior. The typical California subdivision, with home sites of 5,000–10,000 sq ft, using ¾– or 1–in. service lines and house lines, will have 26–44 gpm maximum demand per customer. Approximately 40 per cent of all such customers will require this demand simultaneously. Therefore, the safe average customer demand for typical California first-class residential areas will be approximately 10–18 gpm. In rural areas with small homes, peak demand will range from 6 to 10 gpm per customer, but, because of the number of customers using water simultaneously, an overall average of 4–6 gpm per customer will result. For multiple-dwelling and mercantile areas, where proper design for fire supply has been provided, little trouble should be experienced in meeting the domestic requirements. Population density in typical first-class residential areas is four to five customers per acre, hillside and home site areas one or two customers per acre, and built-up rural areas as many as six customers per acre.

Industrial and agricultural areas present difficult problems for the water works operator. Location and use diversity involve special considerations. Maximum demand of many hundreds of gallons per minute for some industries may be little more than sanitary requirements for others. Where agricultural use is provided by an otherwise domestic water system, off-peak operation must be scheduled. In industrial demand, special consideration must be given to the large customer with such diversified needs.

Service Pressure Zones

Of primary importance is the need to establish service pressure zones as related to reservoirs, pumping plants,

and minimum and maximum static pressures at customers' premises. To allow for line losses, minimum static pressure at customer premises should not be less than 40 psi. Supply and distribution main pressure losses should never reduce pressures at customer premises below 20 psi. Where a system is pressurized by reservoirs, maximum pressures should not exceed 180 psi. For pressures greater than 100 psi, plumbing codes usually require the property owner to install pressure regulators on house plumbing.

When service pressure zones are established, reservoir locations must be carefully chosen as to elevation and pumping plants must be designed with the pumping head necessary to provide such minimum and maximum pressures.

Distribution and Feeder Mains

Distribution mains and feeder mains must be designed as the vehicle necessary to transport the water to the customer. Capacity must therefore be adequate to carry all water required at any time directly to the customer without serious depreciation of service pressures. Grid systems must be well developed with sufficient cross ties and feeder lines to allow for two way feed to fire hydrants wherever possible. Dead end mains must be avoided or reduced to minimum lengths.

Line velocities should not exceed 8–10 fps in distribution and feeder mains, and a conservative use of flow coefficients should be exercised in the initial design. The use of C values in excess of 100 for small pipe, regardless of material or lining, may result in unexpectedly short service life. In general, distribution mains in residential areas, where blocks approximately 800–1,000 ft in length, should be of 6-in. pipe if they constitute a good grid system in which cross-connection lines are 8 in. or greater. Where it is necessary to construct dead-end mains and it is established that there can be no development beyond the presently proposed end, 4-in. pipe would be reasonably safe, but only if the pipe length does not exceed 400 ft, and the line does not serve more than ten or twelve customers. If the distance does not exceed 200 ft and there are no more than four customers, 2-in. pipe could be allowed. In rural areas, where customers are dispersed in a manner that prohibits the installation of frequent interconnections, some modification of the ideal service standard will have to be made, but fire protection must be given consideration and pipe sizes designed accordingly. Three hundred gallons per minute, through 2,000 ft of 4-in. pipe with a C value of 100, will suffer a head loss of approximately 70 psi. The same length of 6-in. pipe with the same C value will lose only 12 psi. Reference is again made to the California Water Supply Standards (*1*):

TABLE 1
Maximum Length of Run

Diameter *in.*	Length *ft*
Unreinforced*	
under 2	none
2	300
3	300
4	1,300
6	2,600
Reinforced‡	
under 2	none
2	600
3	600

* Dead ends.
† Connections at both ends of runs.

Sec. 5.41. The distribution system should be of adequate size and so de-

signed in conjunction with related facilities as to maintain a minimum pressure of 20 psi at every point during periods of maximum normal demand.

Sec. 5.41.1. The maximum length of run of each size of pipe should conform to existing requirements of the proper local authority, but in the absence of such locally promulgated requirements, in no case should the maximum run of pipe be greater than that shown in Table 1.

It is obvious that if a supply is to be provided with a useful pressure residual, very little 4-in. pipe can be used. If ideal service is going to be provided for the customer, quite strict adherence to the above specifications is essential.

Fire Supply

Safe fire supply to supplement modern fire fighting equipment should provide 600–800 gpm as a minimum at each hydrant. Although modern fire fighting methods utilize chemicals and small water flows to great advantage, conflagrations require large streams from readily accessible hydrants. Seven hundred gallons per minute through a 6-in. main with a *C* value of 120 would suffer a head loss of 44 psi per 1,000 ft of pipe. It is therefore obvious that if a useful residual pressure is to be available, hydrants must be supported with a well-interconnected grid system. Spacing of hydrants should not exceed 500 ft, with at least one hydrant at each street intersection. In high-value and industrial areas, multiple nozzle hydrants should be used. In business areas and on main traffic arteries, to preclude the interference of traffic, hydrants should be placed on both sides of the street.

Storage

Storage or pumping facilities of a capacity great enough to provide uninterrupted service involve a great diversity of opinions and ideas. For the system requiring the use of pumps and elevated tanks for maintaining line pressures, little opportunity is offered for large storage reservoirs. Attention must therefore be given to stand-by pumps and power supply. For the system situated upon sloping and hillside terrain, however, reserve can usually be provided by a reservoir. Minimum storage in the amount of 3 maximum day's use is desirable, and where the system is divided into service pressure zones, the reservoirs should be located in a manner that will provide storage for each service pressure zone in proportion to the use of that particular zone. Where it is difficult to find elevations for large storage dispersed throughout the service pressure zones, elevated tanks with a capacity equal to 1 day of maximum use are valuable for providing a nominal assurance of safe supply through overdraft and power outage periods. In water systems where use is predominantly residential with some mercantile and small industrial consumption, the maximum per capita use per day will range from 250 to 370 gal, depending upon location and other diversified factors. Maximum daily use per customer is also variable, ranging from 1,000 to 1,600 gpd in the typical California community. Where the source of supply is adequate to provide total customer use for 1 average day of the maximum month, a reservoir capacity equal to the use through the 3 maximum days of that month should provide a reasonable reserve for overdraft and emergency.

Summary

Briefly, attention must be given to the topography and zoning of the entire serviceable area and to establishing service pressure zones to provide

a minimum static pressure of not less than 40 psi at customer premises. Grid systems designed to provide 15–20 gpm per customer at peak demand with line velocities of not more than 8 fps and conservative use of *C* values, will dictate the use of pipe sizes adequate to provide a safe supply. Provision for a fire supply that will deliver 600–800 gpm to each hydrant at useful residual pressures and at a spacing not to exceed 500 ft will not quite meet the standards prescribed by the National Board of Fire Underwriters, but favorable grading will probably result from such practice. The National Board of Fire Underwriters Bulletin No. 258 (*2*) contains much data that should be used in the higher population density areas. If the water works operator will study customer use experience within his system and design the replacement and expansion of facilities accordingly, adequate, dependable, and safe service will result. In addition, the operator must prevail upon the proper authorities to assist him in establishing standards for water facilities that are enforceable.

Where such items as streets, buildings, construction methods, and plumbing are concerned, the property developer is required to meet minimum standards to insure safe and comfortable living. Why then should there not be a minimum standard for the design of those facilities which provide the most important requisite to our everyday comforts?

References

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Ready-to-Serve Charges for Private Fire Protection

Leonard R. Hanson

A paper presented on Jun. 16, 1955, at the Annual Conference, Chicago, Ill., by Leonard R. Hanson, Director of New Business and Statistics, Dept. of Water and Power, Los Angeles, Calif.

A READY-TO-SERVE charge composed of [1] the "out-of-pocket" costs—that is, all installation, operating, maintenance, meter reading, and billing costs which are attributable to the private fire service connection and detector check or meter, and [2] a reasonable proportion of the costs of the general utility system which makes the service possible, is a fair and equitable periodic charge for private fire protection service. Such a charge can be justified on both social and economic grounds.

Controversy

Fire protection engineers have stated that "probably the most controversial subject in discussions on private fire protection is whether or not the water purveyors should make periodic charges if private fire protection systems are connected to and supplied, in whole or in part, by public water systems" (*1*) and "fire protection engineers believe that there should be very little, if any, charge made for supplying water service to private fire protection facilities" (*2*).

The major points on which these contentions are based seem to be:

1. Private fire protection creates less demand than general or public fire protection and therefore involves no additional cost to the water works.

2. A charge would be considered a double payment in that the property owner is already paying for public fire protection.

3. A charge, if unreasonable, might discourage property owners from providing private fire systems, thereby eliminating a public benefit as well as increasing the public fire protection burden.

4. A 1949 survey (*1*) disclosed that a number of municipal systems did not levy such a charge.

Water works operators, rate-making authorities, and regulatory bodies agree that each class of user should pay the full cost of rendering service.

Relative Demands

The contention that private fire protection does not increase the demand over that of public fire protection is not borne out by experience in Los Angeles. It is not unusual for the Los Angeles department to receive a request for a private fire protection service connection larger in size than the normal distribution main (one which is adequate for the supply to both general use and public fire protection) from which the service would be provided. The need for this large fire service connection is generally caused by pressure and quantity requirements in excess of the public fire protection.

The department does not usually permit a service connection larger than the main to which it would be connected. The request will be approved,

however, if the applicant agrees to pay the additional cost of the larger size of main required. The reason for this practice is that the department feels obligated, within reason, to supply the demand of all service connections approved for installation in the system, giving due consideration to the diversity of the demand.

In requiring the applicant to pay the additional cost for the installation of such an oversized main, it is apparent that the installation costs are not the only consideration. There will be an increase in the maintenance, repair, and depreciation expenses of the larger main. To what class of user, then, should the additional expense be allocated? It would seem to follow that, if it is attributable to private fire protection, the private fire service users should bear a portion of these same expenses on any main to which the service is attached.

Double Payment

The contention that a user of private fire protection service who pays a monthly charge for that service is being charged twice for fire protection—once for public fire protection and again for private fire service—is not valid. The cost of rendering private fire protection service must be paid by someone. If the user of the private fire service does not pay the full cost of rendering that service, and if, as a result, the cost falls on the other classes of users, it is they who would be paying the double charge.

Effects of Demand Charge

Probably the most difficult contention to answer is that a charge, if unreasonable, would discourage property owners from providing private fire systems. It will be explained later that the setting of a rate must fall somewhere between the "out-of-pocket" costs which are attributable to the service and the value of the service to the customer.

Any rate, however, may seem reasonable in the light of rate making and yet seem entirely unreasonable in the eyes of the customer. This is because the customer relates the rate to his own concept of the value of the service. In any event, it is the customer and not the utility that will determine whether the rate is unreasonable and the reasonableness or unreasonableness will be decided by each individual customer rather than by the class of customers.

1949 Survey

The fact that a 1949 survey indicated certain municipal systems which did not levy a charge for private fire protection service is certainly not a valid guide for all water utilities to follow. Without knowledge of the history of these particular utilities, the reasons for not levying such a charge can only be guessed. Perhaps the utilities are furnishing public fire protection at the expense of the utility, and have carried this practice over to the private fire protection service. Or perhaps they are municipally-owned and not self-supporting, so that the revenues are of no particular concern to the manager. Any utility, however, which does not make a proper charge for private fire protection service is obviously loading the expense of that service on the other classes of users, on the general tax payer. If a utility is to stand on its own feet financially, each class of user must pay the full cost of the rendered service.

The fire protection engineers have claimed, on the basis of studies, that, if a water system is properly designed to furnish public fire protection, the

same system will be more than adequate for the supply of private fire protection service. The studies show that relatively small quantities of water were used in extinguishing fire when there was a private fire service and seemed to indicate that, in the case of automatic sprinklers, only a small proportion of the total number of sprinkler heads will open in any one area as the result of a fire.

The paradox here is: If relatively small demands for water will be made by the few sprinkler heads opening in case of fire, why is a service connection capable of supplying many times that quantity of water required?

Economics

A water system exists to acquire, collect, process, and deliver water suitable for the many uses to which its customers put it. The utility must be prepared at all times to render a service that is adequate both in quality and quantity. The service must be available when the customer demands it. In order to provide this service, a large capital outlay in utility plant is required. Source of supply and pumping, storage, purification, and distribution facilities are examples of such a plant. The ratio of capital investment to revenue in a water utility is about 10 to 1. When this is compared to the 5 to 1 ratio common in other utilities (*3*) and the 1 to 1 ratio of most other types of businesses, the effect of water sales on the average unit cost of the water can be seen. From the standpoint of water utility economics, any class of customer who uses water, and thereby reduces the average unit cost of the water, is a benefit to both the utility and those it serves; a class of customer who does not use water, and therefore does not reduce this average unit cost, does not contribute to such mutual benefit.

Because the obligation of the utility to be prepared to meet the demand of each customer imposes heavy capital costs, a separate demand or ready-to-serve charge is not only justified by cost conditions, but is absolutely essential if the joint costs are to be borne fairly by the different classes of users.

The right to charge rates which will cover the cost of providing the service is based on the condition that the service is adequate in both quality and quantity. If this service is adequate, the utility is entitled to charge a rate which will cover the full cost.

Ratemaking Principles

The primary function of a rate or price is to yield a total revenue sufficient to cover the total cost of rendering the service. The cost is probably the most important factor in determining the reasonableness of a rate. Cost of service is generally assumed to be comprised of operating expenses (including taxes and depreciation) and a fair return on the investment in the property used in serving the public. The utility should be permitted earnings sufficient to cover all legitimate expenses of rendering the service. The economics of the cost standard imposes upon the utility an obligation to conduct its operations so that its costs are the minimum necessary to produce the quantity of service which is standard for the time and the commodity (*4*).

The range within which a rate or price can be established is represented by a minimum for individual service which will cover the costs attributable to that service, and a maximum price set by the value of the service to the consumers. Within these limits there

is range for judgment with respect to the specific rate for the service or class of service (*4*). In all cases the rate set must be fair and reasonable, giving due consideration to, among other things, the cost, value, and character of the service (*4*).

The objectives in water utility rate-making are: [1] to distribute equitably, between the various classes of users and between the different individual users, the general costs which are incurred for the entire service; and [2] to bring about an optimum rate of plant utilization.

Los Angeles

Since 1907 the Los Angeles water department policy has been to make a monthly charge for private fire protection service. The charge has, in effect, been applied to all service connections which provide service for private fire protection facilities. This includes automatic sprinkler systems, a combination of automatic sprinkler system and fire hose outlets or fire hydrants, or a system composed exclusively of fire hose outlets or fire hydrants.

Prior to 1928, private fire services were not metered in any respect. Experience, however, indicated the desirability of installing check valves with bypass meters. In 1928 the practice was changed and a check valve with a bypass meter was required on all private fire services. Experience proved that a detector check installation was adequate for automatic fire sprinkler systems which were a closed system except for drainage. It also showed the general inadequacy of a detector check installation for systems which incorporated fire hose outlets or hydrants.

With the advent of World War II and the resulting rapid growth of industry, it was found necessary to insist upon fully metering fire service connections to industrial plants whose systems incorporated fire hose outlets. This was caused by the use of water from the fire protection system for purposes other than those related to fire protection. Newly developed fire flow meters which met the department's requirements as to accuracy and dependability of registration were used.

At present, the Los Angeles policy is to install check valves with bypass meters on all services supplying only a private fire protection system. If the service is used for any purpose other than the fire protection function, it must be fully metered. This is generally accomplished by the use of a fire flow meter which has been approved by the underwriters.

Quarterly inspections of the nearly 3,000 private fire service connections are made to insure that all facilities, including the check valves, are in proper working order. The reading on the bypass meter is taken and, if necessary, an investigation is made to determine how and why water was consumed.

The inspection and investigation expense, while justifiable from an operating standpoint, is considerably higher for private fire service than it is for the general service.

The Los Angeles Charge

The Los Angeles Dept. of Water and Power is a department of the city government and is under the control and management of a Board of Water and Power Commissioners. The commissioners are appointed by the mayor, subject to approval by the city council.

The city charter provides that the rates to be charged for water and water service shall be fixed by the depart-

ment, subject to approval by the city council by ordinance. It further provides that the rates "shall be fair and reasonable, taking into consideration, among other things, the nature of the use, the quantity supplied, and the value of the service."

Current rate schedules, which became effective Apr. 1, 1954, have used, for the first time, a service charge in lieu of the former minimum charge. Management believed that the service charge principle was a more equitable method of collecting a substantial portion of the "ready-to-serve costs."

The service charge is composed of maintenance, operation, and depreciation expense on meters and services, and the commercial expense of meter reading, billing, collecting, and customer accounting. The maintenance, operation, and depreciation expense is rationed on a meter-cost basis. The commercial expense is uniform.

The use of water through a private fire protection service is limited to fire extinguishing and the filling and refilling of facilities which have been drained in connection with tests and repairs. The Los Angeles rate ordinance provides that, if water is used for any other purpose, the service shall be discontinued, and it will not be restored until it is fully metered. The service, then, is supplied at the applicable meter rates.

In applying the service charge to private fire protection service it was decided to increase the basic charge for each size of meter by an amount equal to the charge for 1,000 cu ft of water at the first rate block price.

This 1,000-cu ft quantity was to cover tests and repairs of fire systems which require draining and refilling facilities. Separate billing for these small quantities of water, in addition to a service charge, had caused customer irritation. A quantitative charge is made only for quantities of water in excess of this 1,000 cu ft per month as registered on the bypass meters.

Table 1 shows the comparison of the basic monthly service charge for domestic, commercial, and industrial service with that of the private fire protection service. The $1.60 charge for 1,000 cu ft of water was included in the private fire service charge. With the exception of this amount, the monthly charge for service represents only "out-of-pocket" costs of the service

TABLE 1

Monthly Service Charges

Size of Meter *in.*	General Service $	Private Fire Service $
2	0.92	2.52
3	2.12	3.72
4	4.04	5.64
6	6.80	8.40
8	8.90	10.50
10	12.36	13.96
12	14.96	16.56

connection and detector check facilities. It does not reflect the proportionate and reasonable share of the general facilities which supply the service. The objective for future rate schedules should naturally be to incorporate a fair and reasonable share of the costs of the general system into the charge.

Conclusion

The problem of a ready-to-serve charge for private fire protection is simply one of understanding the obligations and economic characteristics of a public utility, and applying the principles of rate making to this particular class of user in relation to all other classes. That there should be such a

charge is obvious if fairness and equity among all users is to exist.

The charge must be reasonable, taking into consideration the cost, value, and character of the service. It should consist of the "out-of-pocket" costs incurred by installing and maintaining the service connection, and a reasonable part of the costs of the general system which makes private fire protection service possible.

In the allocation of general system or joint costs, there is no single method or formula that will apply equally to all water systems. One reason is the varying degrees of system adequacy existing among water utilities. These are most prominently brought out by system ratings which were made according to the standard grading schedules of the National Board of Fire Underwriters. Another reason is that there is no common policy followed in financing main extensions, service connections, meters, and other facilities.

In allocating the general system costs for private fire service, an allocation should first be made between the general use or users and all fire protection. Then an allocation of fire protection costs between private and public fire protection should be made. In this way, the charge for private fire protection service can be made fair and equitable.

To remove any doubts concerning the validity or the social desirability of making such a charge, it might be well to summarize the recent findings of the New Hampshire supreme court relative to the matter of a periodic charge for private fire protection service *(5)*:

On July 2, 1951, the court ruled on a bill in equity to enjoin the Manchester Board of Water Commissioners from imposing monthly charges for private fire protection service on the grounds that they were illegal, unconstitutional, arbitrary, unreasonable, excessive, and discriminatory.

The court ruled that a private fire service was a peculiar personal service which was not enjoyed by the community in general, but was available only to a limited class of individuals. Private fire protection, it ruled, conferred special benefit for which a reasonable charge may be sustained. A private fire protection system is necessary only because a fire hazard is created by the owner of the property or is inherent in his business, or because the private fire protection is required by law. In either event, the court ruled that special fire protection is sometimes necessary and that a charge for it may be enacted. Because the water utility had established grounds for a private fire protection service charge, on the basis that it is an additional service to the plaintiffs, the court ruled that the municipal water works could not be compelled to provide such additional service without compensation.

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Discussion

Louis E. Ayres

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One may seek in vain in water works literature for any basis or method for the computation of charges for private fire protection by automatic sprinklers. Although many engineers, water works operators, and managers hold to the opinion that a charge should be made for sprinkler service, others are of a contrary opinion. Those in favor of the charge believe that a private connection to the public main for fire protection is in the nature of a demand service, exactly comparable to other demands that are intermittent, but real, and which, in the aggregate, may place a considerable burden on the capacity of the water works. Those opposed to the charge hold that an automatic sprinkler system does not create any additional load on the water plant over the demand already provided by general fire protection. There is just the suspicion, also, that those opposed to the charge are fearful that its imposition may militate against the installation of sprinkler systems, which are generally accepted as helpful facilities in the early control of fires.

It has been reported (*1*) "that 56 per cent of the municipal systems levy no charge for private fire service connections" and that "of those municipal works which do levy charges . . . 57 per cent charge $50 or less per year for a 6-in. connection. A very small percentage have charges that range from $200 up to a little less than $500 a year for each 6-in. connection."

Another recent survey (*2*), covering 23 cities with populations ranging from 7,500 to 1,000,000, indicates the charges shown in Table 2.

New Hampshire Case

A recent decision of the New Hampshire supreme court (*3*) is quite pertinent to the consideration of this controversy. The decision sets forth much of the existing confusion in connection with private fire protection charges and concludes that:

> . . . *standby protection* against fire *is service* whether the water is used or not.
>
> The petitioners claimed that such charges for standby service for private fire protection are illegal, unconstitutional, arbitrary, unreasonable, excessive and discriminatory. They were ready and willing to pay for water on the basis of use.
>
> The defendants claimed on the other hand that the proposed charge is not a water charge in effect, but a charge on readiness to serve, or a standby charge.

The amount of this standby charge was computed by the defendants as a percentage of the *total* cost of "fire protection in general . . . assignable to private fire protection by a comparison of the total possible demands between public and private fire protection." Under this computation, "the annual charge for a 6-in. pipe connection would be $84 . . . , equivalent to $3 per square inch of connection to its mains."

The court ruled that its power to pass on the reasonableness of the charges was generally recognized, but that the "problem of allocation of costs . . . is not easily solved [and]

has always been a rather perplexing one."

The defendants conceded that it was a difficult matter to arrive at an allocation of costs between public and private fire protection. "Plaintiffs produced a competent expert [R. H. Ellis] who testified that there was 'no method . . . by which to allocate what amount should be borne for private as against public fire protection.'"

To indicate how close a margin there was in this case between a reasonable and an unreasonable charge, the court stated that if a charge of $3 per square inch of connection, or $84 per year for a 6-in. connection, had been increased to the original figure proposed by the defendants of $5 per square inch of connection, or $140 per year for a 6-in. connection, "the plaintiff's case would undoubtedly [have been] much stronger."

This case is an amazing example of the courage of the court in asserting its lawful powers to pass on the reasonableness of the charges and decide that *stand-by protection is service,* and of the court's timidity in fixing the amount of the charge in view of the expert testimony by an engineer whose opinion was, in effect, that no separate charge for private fire protection can be justified.

Presumably this conclusion is premised on the assumption that a proper payment has been made to cover general fire protection. As a matter of fact, "such a charge is lacking in most municipally controlled water works," and the charges made by privately owned properties are "frequently in nominal amounts only" (*4*).

Demand Charge

Regardless of the above circumstances, however, the allocation of the percentage of a water works to general fire protection does not mean any specific allocation to any particular plant. In fact, the total amount of such allocation is likely to be determined by the possible fire demands of a central area of hazard, caused by concentrations of business or industrial properties. It is possible, also that any private fire connection might demand its quota simultaneously with a public conflagration.

A connection for private fire protection is not dissimilar to a connection for a private emergency service to a plant obtaining its normal water supply from wells or other independent sources. No one would seriously question the propriety of a demand charge for such a service, even if the existing plant capacity exceeded the total of all probable demands which might be provided for security of service or in anticipation of community growth.

TABLE 2

Annual Charge for Private Fire Service

Size Connection *in.*	Annual Charge $
2	12.00– 93.60
3	18.00– 90.00
4	24.00– 187.20
6	36.00– 312.00
8	48.00– 468.00
10	60.00–1140.00
12	72.00–1620.00

The *AWWA Water Rates Manual* (*4*) presents a method of computing the demand charge, which is the measure of the private fire protection charge. Column 7 of Table 10 in the manual presents such a charge. It is a quarterly charge per meter and is the demand portion of the service charge. Based on the figures used as illustrative application in the manual, the private fire protection charge would be

$85 per quarter for a 6-in. connection, or four times the charge approved in the decision of the New Hampshire supreme court.

In the computation presented in the manual, all fixed charges relating to fire protection, sprinkling, and air conditioning have been assumed to be separately charged, and the balance of the fixed charges only were allocated to demand and to commodity rates on an equal basis. These assumptions and the method of computation have the effect of reducing the demand charge considerably.

In a recent computation applied to the accounts of a Michigan city, in which no deductions were made for special services but methods identical to those of the manual were employed, the private fire protection charge for a 6-in. connection was found to be $56.10 per month or $673.20 per year. Such a figure is far different from the $84 per year granted, with some trepidation, by the supreme court of New Hampshire.

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Richard H. Ellis

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In the paper "Ready-to-Serve Charges for Private Fire Protection," the author has referred to several controversial points, some of which were discussed by the writer in a paper on "Charges for Private Fire Service" (*1*).

In discussing the relative demand for water for the extinguishment of fires in sprinklered and unsprinklered properties, the author states that Los Angeles experience does not bear out the contention that the water demand created by privately protected properties is less than that resulting from public (hose stream) protection. This opinion is based on the not unusual request for fire service connections of a size larger than that of the normal distribution main which would be adequate to supply both general use and public fire protection.

Relative Demands

As explained in the writer's 1950 paper, the recommended size for a private fire service connection is no index of the estimated demand for water, but is rather predicated on minimizing the friction loss in the connection to conserve available pressure and to assure effective delivery from automatic sprinklers.

Fire protection engineers and fire department officials are well aware of the reduction in water demand for fire fighting in properties equipped with automatic sprinklers. Few water works authorities, however, have available tangible data on which to form an unbiased opinion as to the relative demand for private and public fire protection. Evidence to substantiate the contention that private protection facilities require less water than public protection is set forth in a study made by the writer based on National Fire Protection Assn. and Factory Mutual loss records. This study which was summarized in the writer's 1950 paper,

points out that only 15 per cent of the fires in sprinklered properties required 500 gpm for sprinklers and hose streams, while 100 per cent of the fires in unsprinklered properties of similar types and occupancies required that amount or more. Also, 1 per cent of the fires in the sprinklered properties, as compared to 60 per cent in the unsprinklered properties, required 2,000 gpm or more.

The decreased demand resulting from the use of sprinklers is also recognized in an article by A. C. Hutson on "fire flow requirements (*2*). This article, in estimating the water requirement for fire fighting in industrial districts, gives credit for a reduction in the water demand for sprinklered properties. Also, testimony set forth in many court and public utility cases, as well as the National Fire Protection Association summary of sprinkler performance in 58,960 fires during 1925–54 (*3*), clearly establishes the fact that the use of automatic sprinklers results in a decreased demand for fire protection.

Double Payment

It is generally recognized that the two principal functions of a water works are: [1] to provide water for domestic, commercial, and industrial use, and [2] to provide water for fire protection. It is further recognized that, if a water utility is to be self-supporting, it is essential that the costs for these two services should be recovered. To be equitable, these costs should be separated and rates should be established for use and for fire service. This subject is discussed at considerable length in the *AWWA Water Rates Manual* (*4*). Various methods are outlined in this report for the recovery of these costs.

In estimating the operating and capital cost to be allocated to fire protection, it is customary to use the grading schedule of the National Board of Fire Underwriters as a base for determining the fire demand. In this schedule, the estimated demand is predicated on hose stream use for general or community fire protection service, the demand for which, according to the record, would be greater than that required for privately protected properties. The AWWA manual recommends that the cost for such service should be collected as an increment in the property tax or as a separate charge by the water purveyor based on the assessed value of the property protected. Under this arrangement the owners of sprinklered and unsprinklered properties pay their proportionate share of the water works fire protection costs, and the collection of an extra charge from the former amounts to a double billing for the same service. The owners of sprinklered properties are entitled to the benefits of public fire protection just as are the owners of unsprinklered properties. The levying of an additional charge on the owners of sprinklered properties, then, is to deprive them of the benefits of their payment toward public fire service.

In other instances, the fire protection costs are included in the rate for use, in which event all properties are charged for fire service in proportion to the amount of water used on the premises. While this latter method of recovering fire service costs may be less equitable than the former, it stands to reason that the large water users, such as manufacturers and others who normally install sprinkler protection, are assuming a reasonable proportion of the general fire service costs. Therefore, unless it can be established that there are additional costs involved in

furnishing service to a sprinklered property over and above the costs of providing general or community fire protection, any additional charge (monthly, quarterly, or annual) for private fire service connection does result at least in part, in the property owner paying twice for the same service.

Effects of Demand Charge

It is obviously to the interest of all municipal authorities to reduce to a minimum the community fire loss. A major factor in the reduction of fire losses has been the installation of sprinkler protection in industrial and mercantile properties. A 1938 study by Horatio Bond, Chief Engineer of the National Fire Protection Assn., of sprinkler installations in 50 cities ranging in population from 51,000 to 1,550,000 indicated that the proportionate number of completely sprinklered buildings within congested-value business districts was more than four times greater in those cities without excessive water utility requirements than in those where high annual charges and expensive meter requirements are imposed for private fire service connections. Thirteen per cent of the buildings in the group of 25 cities without excessive requirements were sprinklered, as compared to 3 per cent in the latter group of an equal number of cities.

While this study covered only a limited number of cities with widely different requirements, it did, at that time, indicate a trend and appear to justify the contention that high charges discouraged property owners from installing private fire protection service.

1949 Survey

The writer's 1950 paper, based on a 1949 survey of water works practice relative to fire protection requirements, was a factual report based on returns from 1,269 utilities. It was not offered as a guide to be followed by all water utilities. It is not necessarily true, however, that the average of the utilities furnishing this data were not, in some way, recovering their costs or that they were furnishing fire protection service at a loss.

Charges

The author's paper is based on the definite assumption that an additional service is rendered by the water purveyor to the owner of sprinklered properties over and above that available to the owner of unsprinklered properties. Both may be entirely dependent on the public water system for the fire protection supply. Both require preparedness to serve, one through private facilities and the other through hose streams made available by the public fire department. Both should be expected to contribute a fair share of the water utilities fire protection costs, but the logic of levying an additional ready-to-serve charge on the owner of the sprinklered property for the same or less service than would be rendered to the owner of unsprinklered property appears to be an unjustified procedure.

The justification for a demand or ready-to-serve charge for private fire protection hinges on whether or not the condition of demand for sprinklered properties is different from the condition of demand resulting from fire department hose use. In either situation the water utility stands ready-to-serve, and to a lesser degree in the former case. Readiness-to-serve, then, does not appear to be a factor attributable alone to private fire protection.

There can be no disagreement with the principle set forth by the author

that "the primary function of a rate or price is to yield a total revenue sufficient to cover the total cost of rendering the service." The "value of the service to the consumer" is a questionable base on which to establish a maximum price, however, or, for that matter, any price.

To establish prices for commodities or service on the value to the user would be contrary to accepted practice. It would result, for instance, in a person having to pay more for a small light-weight business car than he would pay for a luxury type car for family use, on the basis that the former would be of greater value to him by aiding in earning his livelihood. Such a base for the establishment of rates has been discarded in numerous public utility, court, and interstate commerce commission cases (*5*).

Los Angeles Experience

Attention should be called to the fact that the Los Angeles experience relative to charges, according to the author, is not truly based on a ready-to-serve charge but appeared, rather, to be designed for recovering the extra cost of inspection, servicing, and maintenance of meters and appurtenances which the water department requires on fire protection services.

The author's recommendation relative to the allocation of water works cost for general use and for fire protection service follows the recommendations made by the AWWA rate committee and the various writers who have discussed rate making. It disposes of private fire protection rates by simply recommending an allocation of fire protection costs between private and public fire protection. That is the unsolved question and the one for which the justification is questionable if we are to base our judgment on relative demand for water for extinguishment of fires in protected and unprotected properties. Relative to the legal findings in rate cases of this type, many court cases are settled on the basis of previous rulings rather than upon the equity involved in the particular cases in question. It may be perfectly legal to establish rates which are not necessarily justified on the basis of equity.

Demand Charge

Louis E. Ayres has referred to the possibility of a private fire service connection creating a demand simultaneously with a public conflagration. This possibility exists, but it must be remembered that the same possibility exists where total dependence is placed on hose streams by public departments. For instance, in cities of over 200,000 population, the National Board of Fire Underwriters grading schedule requires "12,000 gpm with 2,000 to 8,000 gal additional for a second fire, for a 10-hour duration." The possibility of simultaneous fires occurring in the smaller communities is less than in the larger cities.

The demand charge referred to in the AWWA manual is a charge for possible maximum rate of use. At no time during its discussion of this subject did the AWWA Water Rates Committee consider that this charge should be allocated to fire protection services. With an equal or greater demand by unsprinklered properties, it would appear discriminatory to apply such an additional charge, based on demand and predicated on the size of the connection, which is not a true index of requirements, against the owners of protected properties.

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Author's Closure

Richard H. Ellis' discussion appears to revolve around two points: [1] that the condition of demand for sprinklered properties is not different from the condition of demand for public fire protection and, therefore, a demand or ready-to-serve charge is not justified; and [2] that the value of the service is not a fair basis on which to establish a maximum price for any rate including private fire protection service.

Relative Demands

In support of his contention that the condition of demand for private fire protection service is less than that for public fire protection service, he states that the size of the service connection is not the index of the estimated demand for water, and that a summary of National Fire Protection Assn. and Factory Mutual loss records shows that only 15 per cent of the fires in sprinklered properties required 500 gpm or more, while all fires in unsprinklered properties of similar types and occupancies required that amount or more.

In the Los Angeles system, the size of the service connection is an *index* of the estimated demand for water. It is obvious that a summary of loss records is a history of the quantities of water used, and this is something greatly different from the potential demand which existed. It can be assumed without doubt that, in considering a water system for private fire protection, fire protection engineers would not condone a design which was based on such loss records rather than on the desired quantities of water as related to the size of the service connection installed.

If 15 per cent of the fires mentioned required 500 gpm or more, to use Ellis' statistics, probably 85 per cent of the private fire systems required less than 500 gpm. Generally, the Los Angeles system will deliver 500 gpm at sufficient pressure through a 4-in. service connection. It seems, however, that $66\frac{2}{3}$ per cent of the Los Angeles private fire service connections are larger than 4 in. This would indicate, in relation to the discusser's statistics, that Los Angeles is probably providing private fire service connections larger than those actually required.

The points that must be made, however, are: [1] that a summary of loss records shows the actual quantities of water used and does not show the potential demand that actually existed on the system; [2] that the size of the service connection is an *index* of the estimated demand; and [3] that the public fire service requirements, to the author's knowledge, are never reduced when private fire systems are installed.

Value of Service

The discusser has stated that "the value of the service to the consumer" is a questionable base on which to establish a maximum price, or for that matter any price. Such price setting, he feels, would be contrary to accepted practice. What was actually stated in the author's paper was that the price for a given class of service can be established *within a range* bounded by a minimum based on the "out-of-pocket" costs and a maximum based on the value of the service to the consumers, and that within this *range* there is room for judgment with respect to the specific rate or price to be set.

The "value of the service" in rate making is used primarily as a measure of the reasonableness of the rate and should not be used as the sole determinant in setting a price.

Ready-to-Serve Charge

The discusser admits that private and public fire service "both require readiness-to-serve" and that "both should be expected to contribute their fair share of the water utilities fire protection cost." There can be no question to the fact that the unsolved problem is one of allocating the investment and expense of facilities which are used jointly for several types or classes of service. About the only answer to the problem is to apply the best judgment possible to this type of allocation for any specific water system.

There is no doubt that every water utility must hold itself in readiness to meet the demand of the various classes of users and it is therefore required to make large capital investments. Certainly, then, the class of private fire protection service adds investment and operating costs to the system. And, just as certainly, a non-user of water cannot normally return these costs to the utility through a quantitative rate for the commodity.

The only way in which the utility can recover the cost of rendering the service, therefore, is through a demand or ready-to-serve charge.

Modernization of Chicago's Pumping Stations

O. B. Carlisle and J. L. Weeks

A paper presented on Jun. 15, 1955, at the Annual Conference, Chicago, Ill., by O. B. Carlisle, Chief Water Works Engr., Water Design Div., Bureau of Eng., Chicago, Ill., and J. L. Weeks, Mech. Engr. in Charge, Operating Div., Bureau of Water, Chicago, Ill.

THE items that enter into the modernization programs of Chicago's pumping stations are too numerous to discuss in detail. The author will attemp only to bring out the highlights of the problems that must be continually solved in maintaining these installations in good operating condition. The modernization of a pumping station is a project that always occurs in the life of any well run water supply system where such plants are a necessity.

Chicago now has eleven pumping stations in operation, with an average daily output of over 1 bil gal. The oldest was placed in service in 1854; the newest in 1936. Throughout the years, all of these plants have been subjected to modernization in varying degrees of magnitude and range, depending on the length of time of service. When a new station is placed in operation, management is inclined to relax and congratulate itself that this modern installation will be reliable, efficient, and of ample capacity to meet peak loads for many years to come. Unfortunately, the equipment wears out, maintenance cost increases, efficiency drops off, and reliability becomes questionable. Moreover, it becomes apparent that the increased demands for more capacity cannot be met. At such times, major replacements of equipment are required. Modernization does not necessarily mean only replacements. Also included are the provision of better equipment and methods and the substitution of the latest proved developments in the art of handling water.

Although a station can operate satisfactorily for many years with periodic overhauls and minor repairs, such a procedure only delays the time when a major rehabilitation becomes a prime necessity. It is appreciated that the first fundamental requirement of a pumping station is continuity of operation to eliminate the disastrous effects of a breakdown. There must also be sufficient capacity to handle present and future peak loads, with reserve or standby units to be used in emergencies. Efficiency, although a definite requirement, is always subordinate to reliability. In an attempt to meet these necessities, the best available time-tested equipment should be required. Although the initial cost will be a little higher, experience has shown that such a procedure is actually less expensive in the long run.

In the modernization of pumping stations, a serious attempt is made to comply with all of the fundamental requirements, as it has been found from actual experience that the success of such efforts has eliminated a lot of criticism from customers, all of whom, naturally, demand a dependable and

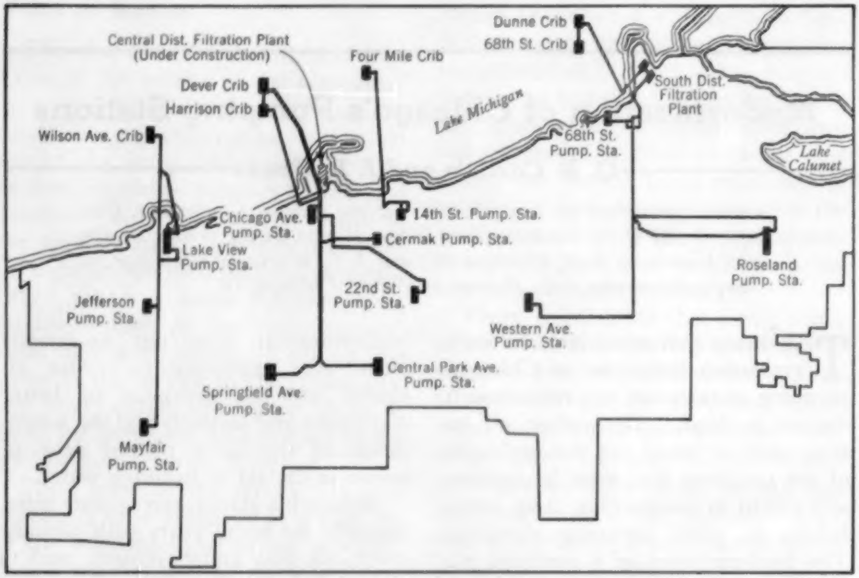

Fig. 1. Intakes and Pumping Stations at Chicago

Five of the pumping stations are electrically driven. The other six are run by steam. The 14th St. pumping station has been permanently out of service since Dec. 31, 1954.

adequate supply. The pattern of modernization varies. In five of the eleven stations (Fig. 1), pumps are electrically driven, and their maintenance in an up-to-date condition does not present quite as complicated a problem as do those that are steam-driven.

Electric Pumping Stations

Chicago Avenue Station, the oldest, started operation a century ago as a steam station with a capacity of 8 mgd. The building was entirely rebuilt in 1869 and since then the plant has had at least three modernization programs. It now is an electric station with a capacity of 160 mgd. The latest major improvement, just completed, was the installation of new electric switchgear, transformers, and conductor cables, replacing the original equipment installed in 1921.

The 22nd Street Station, the next oldest, began operation in 1876 as a steam station with a capacity of 30 mgd. After passing through several rehabilitation programs, the plant is now electrically driven, with a capacity of 70 mgd. This installation is quite old and its future as a necessary station is now in question.

Cermak Station, built in 1936, with a capacity of 300 mgd, is the most modern plant. Nevertheless, it is now undergoing its first major modernization project in the transformer room to comply with the ever-increasing requirements for electrical safeguards. This situation indicates how quickly "modern" can become "obsolete."

Thomas Jefferson Station, electrically operated and built in 1928, with a capacity of 100 mgd, was subjected to its first major overhaul last year.

getting a complete replacement of its switchgear to comply with modern standards of safety and reliability.

The 68th Street Station, acquired by the city in 1889 through annexation of the area served, has been through several programs of modernization. This plant originally had a capacity of 40 mgd and was steam operated. Conversion to electricity started in 1919. Capacity since then has been increased to 240 mgd by the successive addition of new pumping units to meet increased demands. The anticipated replacement of one of the original 40-mgd electric-driven pumps with a modern 50-mgd unit will raise the capacity to 250 mgd.

The modernization of the steam-operated stations, from the design, operating, and construction standpoint, presents much more difficult problems than those encountered in the overhaul of plants powered by electricity, because larger and more varied types of equipment are concerned, such as boilers, stokers, steam turbines, coal- and ash-handling systems and many auxiliaries. Moreover, the new equipment generally requires more room than the old and must be arranged to fit into the space available in the old building, whereas in the original installation, the structure was designed to accommodate the apparatus. During alterations, the station must always remain in reliable operating condition, a situation which often permits the work to be done only during off periods and requires that great care be taken to protect adjacent equipment from damage. Thus, progress is slow and costs are high. Rehabilitation in two steam stations necessitated greater pressures, and extreme care had to be taken in the transition period to keep high pressure out of the low-pressure equipment.

Benefits of Modernization

Many new items of equipment installed under modernization programs are a distinct improvement. For example, the ball valves in the suction and discharge lines of large pumping units have replaced the older gate valves. The new valve is easier to operate and is tight, possesses metal seats, and when open has no obstruction to produce a loss in head. Any impedance becomes an appreciable item where velocities of the water in the pipe range from 12 to 20 fps. Cone valves, as acceptable in performance as ball valves, are sometimes more costly, weightier, and more space consuming than ball valves. In the large discharge pipe vaults, which are detrimentally damp, the corrosive effects of the humidity on the equipment is damaging, especially to electrically operated mechanisms, even when insulating covering is used. The elimination of humidity has been accomplished in the largest pipe vault at the Western Avenue Pumping Station by the installation of a dehumidifying system that has proved exceptionally successful.

Every boiler modernization program has consisted of changing from the old, standard sectional header, straight-tube boiler to the modern multiple-drum bent-tube boiler. The new boilers have been of a conservative design, with a large drum capacity, so that more water and steam in storage are ready for instant use. The boiler furnace design is also conservative, thereby keeping the temperature reasonably low and maintenance to a minimum. Water-cooled areas are also held as small as possible in order to reduce smoke at low loads. The modern un-

derfeed stokers, a vast improvement over the older types, are favored because they are efficient, can burn any available poor coal at high ratings, have a good design for disposing of ash, and permit a simpler boiler installation with a minimum of auxiliary equipment.

Modern turbine-driven pumps are greatly superior to the older units in both efficiency and design, and the use of better corrosion-resistant metals has helped to reduce maintenance problems. Modern methods of construction permit designs of nozzles, turbine blades, and pump wheel contours to be made with well regulated angles, resulting in the lowest possible energy losses. Pronounced improvements have also been made in centrifugal-pump efficiencies without resorting to extremely close clearance or to features that could, in part, be classed as experimental.

Modernization has also taken place in the chlorine feed equipment, placed at the cribs in 1912 and at the pumping stations in 1915–16. Because the original methods of handling the gas were found unsafe and unsatisfactory, the city in 1923 began installing machines of the water diaphragm type, which embodied every possible safeguard and gave reliable and accurate results. Since then, machines of larger capacity have been installed, permitting the use of 1-ton containers instead of the old 100- and 150-lb types, thus reducing the number of operating units without sacrificing any safeguards or reliability, and helping to meet the increasing demands upon equipment and facilities.

Chicago's Experiences

Modernization has helped to bring about the degree of dependability required for municipal pumping. During World War II, Chicago's rehabilitation activities were curtailed, of course, and it proved advantageous to have had new equipment, which was able to function far beyond the normal period for replacement. Since the war, progress has been made toward bringing the stations to a point where they can better meet pressure and capacity demands and where reliable operation does not depend solely on chance. Five of the six steam stations have been subjected to an almost continuous modernization program in the past few years. Old boilers and pumping units have gradually been replaced with modern equipment of larger capacity, not only to obtain greater efficiency and reliability, but also to meet the constant demands for more water at better pressures.

In the Central Park Avenue Station, erected in 1900, the four original triple-expansion engines with a total capacity of 100 mgd (increased to 125 mgd by the installation of a centrifugal-pump unit in 1914) were replaced during 1922–26 by three 60-mgd turbine-driven centrifugal pumps, bringing the station capacity to 189 mgd. In anticipation of this change, the original hand-fired Scotch marine boilers had been replaced a few years earlier with five new stoker-fired units. In 1936, an 80-mgd pump was installed, raising the station capacity to 260 mgd.

In order to provide steam power to operate the existing pumping units, as well as additional ones in the future, it was again necessary to replace the old, inadequate boiler plant, completed in 1918, with a larger, modern, and more efficient plant which was completed in 1944. In 1950, another 80-mgd pump was installed, increasing capacity to 340 mgd. In 1955 the first 60-mgd turbine-driven pump, installed in 1922,

will be replaced with a new, modern unit of the same capacity. The following year, the second old 60-mgd pump will be supplanted by a new 80-mgd unit. When this installation is accomplished the station will have a capacity of 360 mgd.

The Springfield Avenue Pumping Station, a sister station to the Central Park Avenue Station, was also placed in service in 1900 with an installed capacity of 60 mgd. The plant consisted of vertical triple-expansion engine pumps, which, in those days, were considered the last word in equipment. By 1914, the capacity had been increased to 125 mgd. During 1922–26, all the old units were replaced by three turbine-driven centrifugal pumps with a total capacity of 180 mgd. The boiler plant, in the meantime, had been rehabilitated by the replacement of old boilers with three new ones, increasing the steam capacity to meet the added load. In 1936, a new 80-mgd pump was installed to meet the increasing demand, raising the station capacity to 260 mgd. In 1950, another 80-mgd unit was added, raising the capacity to 340 mgd. In order to provide sufficient steam power, an efficient and modern boiler plant was placed in service in 1953. It was built on a site independent of the old plant, which could be kept in full operation during construction of the new. This installation is one of the few major developments, which, during construction, in no way interfered with existing operations. At present, the appearance of the front of the old pump room is being improved by replacement of the facing.

The Mayfair Pumping Station was placed in service in 1918 with an installed capacity of 135 mgd provided by six vertical triple-expansion engines. Because of increasing demands for water, two steam turbine–driven units of 60 mgd each were installed in 1932, increasing the capacity to 255 mgd. In 1955, the second major improvement was completed by replacing two of the original pumps with two 60-mgd turbine-driven centrifugal units, raising the capacity to 325 mgd. The boilers at this station, after 35 years of service, are at present being replaced with larger units to handle the increased load from the new pumps. Six new boilers and stokers will be installed, together with new coal- and ash-handling equipment. When finished, this plant will be modern, reliable, more efficient, and capable of meeting not only the present load, but also the future pumpage required for the area.

The Western Avenue Pumping Station, placed in service in 1927, is equipped with four 75-mgd steam turbine–driven centrifugal pumps that provide a capacity of 300 mgd. For many years this plant has pumped more water than any other of Chicago's eleven stations. As a result of the 28 years of steady, heavy loads on the operating equipment, replacements of boilers, stokers, and pumps are now being made. The new equipment will consist of four 650-hp boilers and three 85-mgd pumps. When this program is completed, the station will have a capacity of 350 mgd.

The Roseland Pumping Station, which also has gone through several modernizations, was placed in service in 1911. Originally equipped with two 25-mgd vertical triple-expansion pumps, the plant was provided with two more 4 years later, raising the capacity to 100 mgd. Because of the rapid increase of population in the area served, a long-range program for

increasing the station capacity was started in 1941. Between 1942 and 1948, the boiler capacity was increased by the replacement of the six original 300-hp boilers with four of 600 hp. In 1944 and 1949, two of the pumps that had been installed initially were replaced with two 75-mgd steam turbine-driven units, increasing capacity to 200 mgd. In 1954, the third original pump was supplanted by a 75-mgd steam turbine-driven centrifugal unit, placing the station capacity at 250 mgd. In 1955, the last of the original pumps will be replaced by two 40-mgd turbine-driven units, which will bring the installed capacity to 305 mgd. In order to obtain greater flexibility and reliability in the discharge system of this station, a new double header installation with electrically operated rotary plug type valves will be located in the pipe vault. When completed, the discharge line from all five pumps will be interconnected so that any one can discharge into either of the four distributing mains radiating out from the plant.

All of the modernization programs have attempted not only to obtain and install efficient and reliable equipment, but also have endeavored to improve the working conditions and safety of the personnel, a situation which will also provide better operating efficiency. New passenger elevators are being installed, wherever required, in both the pump room pits and boiler rooms so that an operator can reach the highest or lowest parts of the equipment easily and quickly. Easy access is thus furnished to equipment that is difficult to reach and that otherwise might not receive proper attention. Ventilation is constantly being improved in the pump and boiler rooms, a fact made possible by apparatus that has become available recently. The handling of coal and ashes, always an unglamorous task in coal-burning stations, is being improved by the installation of modern, labor-saving, material-handling equipment that eliminates dust.

Conclusion

When the present program of modernization is complete, Chicago's water supply system will be in excellent operating condition. As time passes, however, equipment will become obsolete and inefficient and unexpected changes will occur. Consequently, it must always be kept in mind that eternal vigilance in determining the present and future needs of the pumping stations and acting on these demands are requisites for providing a water system that has the dependability, efficiency, and capacity, capable of meeting any emergency.

Solution Effects of Water on Cement and Concrete in Pipe

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A paper presented on Jun. 16, 1955, at the Annual Conference, Chicago, Ill., by Martin E. Flentje, Research Engr., American Water Works Service Co., Merchantville, N.J., and R. J. Sweitzer, Sales Repr., Lock Joint Pipe Co., East Orange, N.J.

THE use of cement and concrete for water mains is so well established in the water works industry that little need be said about the importance and reliability of these materials. Many miles of concrete pressure pipe are in transmission and distribution systems throughout the world. Some of this pipe is now more than 50 years old. As a lining for mains, cement has been employed for about 110 years (*1*). Nearly 70 per cent of the cast-iron pipe now in use is cement lined. In addition, some lines are constructed of asbestos-cement pipe. Thus, it is readily seen that cement is involved in an impressively high percentage of existing water mains, and this percentage is increasing rapidly.

The extraction by water of chemical salts from cement, concrete, and cement mixtures has often been noted (*1–4*). In practically all cases, the solution effect of water on cement compounds has been found to disappear in a relatively short time (*1*). There has been occasional speculation that the solution process could reach the point at which enough calcium would be removed to cause failure of the cement or concrete. This paper is a preliminary report on the results of an investigation into the solution effect.

Definitions

In this paper, concrete pipe is defined as a steel-reinforced pressure pipe with a concrete surface exposed to the water being transported and a concrete or mortar coating on the outside of the pipe. Where concrete pipe is referred to in relation to a cylinder, it is meant that the pipe is constructed in the form of a steel cylinder with an inner concrete lining and a concrete or mortar coating on the outside. Some of the concrete pipe under consideration is of a prestressed design, in which the concrete lining, or core, and the steel cylinder are placed in compression by a tension-wound high-strength wire. The cylinder and the wire are then coated with either mortar or concrete.

The term "cement lining" refers to the cast-iron or steel pipe mortar lining, which is composed of a mixture of sand, cement, and water. It is applied either centrifugally or with a trowel. An attempt is made throughout the paper to differentiate between mortar and concrete, both as lining and coating. The difference is that the concrete contains a coarse aggregate, in addition to the sand and cement mixture of mortar.

Portland Cement

Portland cement, the material common to concrete pipe of all kinds and to asbestos-cement pipe and cement linings, is a rather complex material about which much is known but about which there are still unknown factors. The standard specifications of the ASTM for portland cement (*5*) describe this material as "the product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates, to which no additions have been made subsequent to calcination other than water and/or untreated calcium sulfate."

In the reactions of water with cement, both hydration and hydrolysis take place. Hydration is the direct addition of water to the anhydrous or partially hydrated compound, as in the formation of blue $CuSO_4 \cdot 5H_2O$ when H_2O is added to white $CuSO_4$. Hydrolysis is an interaction with water such that the H ion of the water becomes associated with the anion of the compound, and the OH ion becomes associated with the cation. Hydration and hydrolysis probably take place simultaneously, and $Ca(OH)_2$ is produced in each case (*6*).

Portland cement is composed mainly of tricalcium silicate, dicalcium silicate, and tricalcium aluminate, together with lesser amounts of iron and magnesium compounds. When mixed with water, the compounds hydrate, especially the calcium silicates, and this basic reaction causes the cement to set and develop strength. In this hydration process the calcium silicates go into solution, release calcium hydroxide, and are precipitated again, chiefly in the form of hydrated monocalcium silicate.

TABLE 1

Typical Analyses of Portland Cement (7)

Oxide	Amount—*per cent of total*				
	Type I	Type II	Type III	Type IV	Type V
SiO_2	21.3	22.3	20.4	24.3	25.0
Al_2O_3	6.0	4.7	5.9	4.3	3.4
Fe_2O_3	2.7	4.3	3.1	4.1	2.8
CaO	63.2	63.1	64.3	62.2	64.1
MgO	2.9	2.5	2.0	1.8	1.1
SO_3	1.8	1.7	2.3	1.9	1.6
Loss	1.3	0.8	1.2	0.9	0.9
Insoluble	0.2	0.1	0.2	0.2	0.2
Potential Phase Composition	Average Amount—*per cent of total*				
C_3S*	45	44	53	28	38
C_2S†	27	31	19	49	43
C_3A‡	11	5	11	4	4
C_4AF§	8	13	9	12	9

* Tricalcium silicate, $3\,CaO \cdot SiO_2$.
† Dicalcium silicate, $2\,CaO \cdot SiO_2$.
‡ Tricalcium aluminate, $3\,CaO \cdot Al_2O_3$.
§ $4\,CaO \cdot Al_2O_3 \cdot Fe_2O_3$.

Five types of cements are recognized in the United States. The general characteristics of these five types are as follows:

Type I—ordinary cement; used in general concrete construction, where cements having special properties are not required.

Type II—moderate-heat-of-hardening cement; used in general concrete construction exposed to moderate sulfate action or where moderate heat of hydration is required.

Type III—high-early-strength cement; used when high early strength is required. This cement is characterized by a very fine grind.

Type IV—low-heat cement; used when a low heat of hydration is required.

Type V—sulfate-resisting cement; used when high sulfate resistance is required.

The types in most prevalent use for pipe manufacture are Types I and II, with some Type V for special cases.

Table 1 shows chemical analyses of these five types of cement. The oxide percentages do not vary greatly, but wide differences exist in the potential composition. It is these dissimilarities that give the cements their individual performance characteristics.

TABLE 2

Concrete Pressure Pipe Samples

Sample	Type of Pipe	Diameter *in.*	Core Thickness *in.*	Length of Service *years*	Langelier Index ($pH - pH_s$)
A	Cast	30	$1\frac{1}{4}$	5	−2.10
B	Cast	36	$1\frac{3}{4}$	25	+0.04
C	Spun	16	1	3	−3.51
D	Spun	36	1	22	−0.09
E	Spun	30	$1\frac{3}{4}$	4	−1.10

The slurry formed by mixing cement and water hardens on standing to form a cementitious paste which is the bonding agent in mortar and concrete. As the cement sets and hardens, hydrolysis reactions take place which result also in the formation of calcium hydroxide, $Ca(OH)_2$ (*5, 6*). This may be shown as:

$$(CaO)_3 \cdot SiO_2 + 4\tfrac{1}{2}H_2O = CaO \cdot SiO_2 \cdot 2\tfrac{1}{2}H_2O + 2Ca(OH)_2$$

Calcium hydroxide is a chemical compound that is sufficiently soluble in water (1200–1600 ppm) to affect seriously water hardness. In a natural water containing CO_2 and bicarbonates, the first effect of adding dissolved $Ca(OH)_2$ is the conversion of the carbon dioxide to calcium bicarbonate. The next step is conversion of bicarbonates to normal carbonates after which $Ca(OH)_2$ itself stays in solution. Except for the conversion of bicarbonates, these reactions result in increasing hardness and pH. The equation above shows that a considerable supply of $Ca(OH)_2$ is available in the cement component of the pipe or coatings made of this material.

TABLE 3

Analysis of Water Supply in Samples

Sample	Alkalinity (as $CaCO_3$)	Total Hardness (as $CaCO_3$)	Calcium	Total Solids	pH
A	24	44	19.2	220	6.8
B	180	188	70.6	245	7.5
C	6	14	4.0	24	6.7
D	80	94	89.0	135	8.0
E	58	68	18.0	140	7.45

Investigation

In this part of the survey, samples of five concrete pipelines were obtained

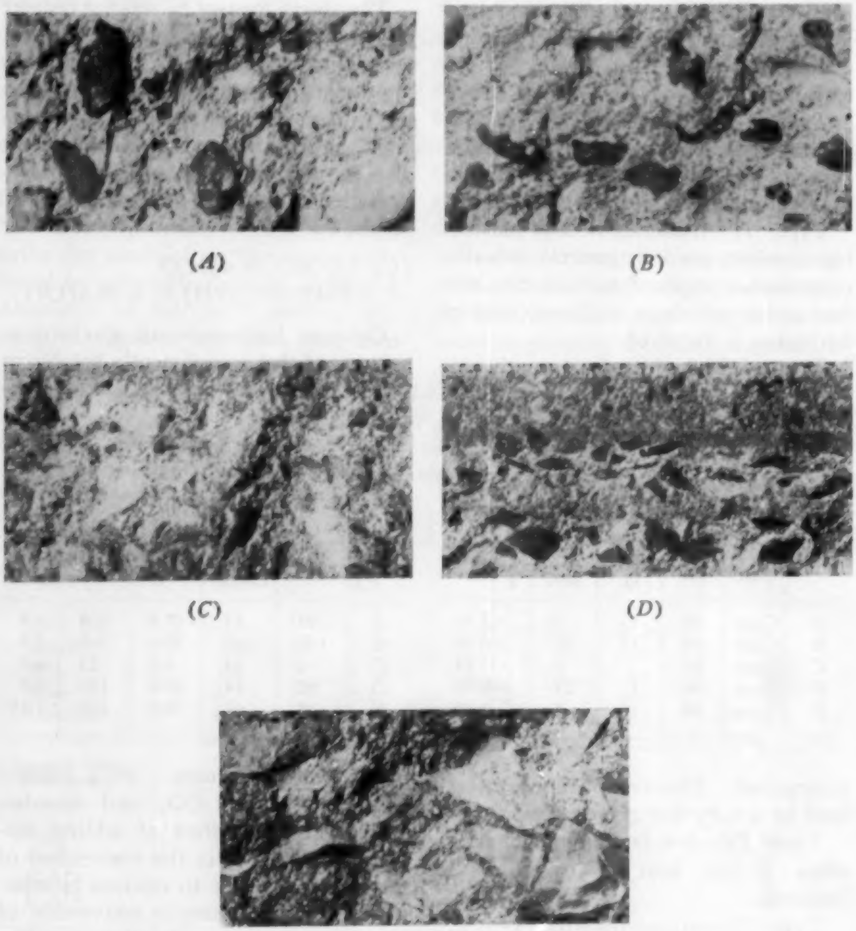

Fig. 1. Samples of Concrete Pipelines

Locations and installation dates for the samples are as follows: (A) *Norfolk, Va., 1940;* (B) *St. Petersburg, Fla., 1929;* (C) *Portland, Me., 1950;* (D) *Montreal, Canada, 1930; and* (E) *Birmingham, Ala., 1950. The photographs were taken at time of testing, and the aggregate, as shown, is actual size.*

for analysis and testing. The test locations were selected because of the availability of the samples, because various types and ages of pipe were represented, and because there had been exposure to waters that represented several degrees of aggressiveness. Table 2 gives pertinent data on the lines, and the water supplies involved in each sample are analyzed in Table 3.

The appearance of these lines after the indicated years of service can be judged by examining Fig. 1. Table 4 shows the results of tests made on samples representing the entire wall thickness of the pipe sections shown in the photographs. By referring to the typical analysis of portland cement given in Table 1, it can be seen that the cement component of the concrete in each of these pipe samples is essentially unchanged.

TABLE 4

Analysis of Cement Used in Samples *

Item	Amount—*per cent of total*				
	Sample *A*	Sample *B*	Sample *C*	Sample *D*	Sample *E*
SiO_2	21.8	24.8	22.7	20.7	20.0
Al_2O_3	7.5	5.9	6.6	7.8	6.6
Fe_2O_3	3.9	2.0	5.2	3.3	2.9
CaO	61.1	64.4	60.0	60.3	64.4
MgO	3.6	1.5	3.3	5.6	3.3
SO_3	2.1	1.5	1.9	1.8	2.5
K_2O	0.15	0.00	0.25	0.30	0.28
Na_2O	0.00	0.00	0.10	0.24	0.07
Total	100.15	100.10	100.05	100.04	100.05

* Cement sample tested represents entire wall including inner surface.

Tests

The following procedure was followed with each of the five samples which was studied:

1. Each sample was given a careful visual examination and then photographed in plan and cross-section.

2. The thin, brownish, rather soft surface layer was carefully scraped from each sample. This layer was examined separately, and was heated to 600°C before analysis to drive off any water of hydration.

3. After removal of the surface film, each sample was equally divided with respect to the inner and outer surfaces of the pipe wall. Each of these sections was then examined physically and chemically.

The chemical composition of the chalky, brownish layer, as determined by the tests made, is shown in Table 5. The analytical results indicate a loss of calcium from the inner surface of the concrete pipe, with an apparent deposition of magnesium and iron. This might indicate that solution of $Ca(OH)_2$ from the cement took place. Both magnesium and iron would precipitate at the pH values resulting from the solution of $Ca(OH)_2$ in the early stages of use of such lines.

It is believed that these results also indicate that, although solution of $Ca(OH)_2$ very quickly reaches a certain degree of activity, it then slows down and eventually stops altogether. As mentioned, each of these samples had a thin layer of material that was nearly of the same depth as in each of the other samples. This layer was deficient in calcium and contained somewhat increased contents of magnesium and iron, suggesting the possibility that a condition is reached which halts the solution of calcium when the surface layer becomes a certain thickness. Exactly what occurs here has not yet been determined. The analysis in Table 6 shows that the calcium removal has not progressed into the body of the concrete.

TABLE 5

Composition of Inner Pipe Surface Layer *

Item	Amount—*per cent of total*				
	Sample *A*	Sample *B*	Sample *C*	Sample *D*	Sample *E*
Acid Soluble					
SiO_2	5.2	3.9	24.2	23.1	27.5
Al_2O_3	4.5	0.62	9.2	8.0	7.5
Fe_2O_3	2.2	0.78	5.2	3.9	3.9
CaO	5.0	8.8	13.8	10.2	31.1
MgO	2.2	1.2	10.0	15.2	12.4
SO_3	2.4	0.29	0.88	0.66	1.7
K_2O	0.11	0.00	0.19	0.07	0.28
Na_2O	0.04	0.04	0.18	0.05	0.13
Total	21.6	15.6	63.7	61.2	84.4
Acid Insoluble	77.3	78.3	31.5	34.0	12.9
Ignition Loss	1.0	6.1	4.8	4.8	2.7
Total	99.9	100.0	100.0	100.0	100.0
	Amount—*per cent of acid soluble portion*				
SiO_2	23.9	25.0	38.0	37.7	32.6
Al_2O	20.9	4.0	14.4	13.1	8.9
Fe_2O	10.2	5.0	8.2	6.4	4.6
CaO	22.9	56.0	21.6	16.7	36.8
MgO	10.2	7.9	15.8	24.8	14.7
SO_3	11.2	1.8	1.4	1.1	2.0
K_2O	0.51	0.00	0.30	0.12	0.34
Na_2O	0.20	0.26	0.28	0.08	0.15
Total	100.01	99.96	99.98	100.0	100.09

* Thickness of inner layer in Samples *A*, *B*, *C*, and *E* was $\frac{1}{16}$ in.; for Sample *D*, $\frac{1}{8}$ in.

Also in Table 6 are shown analyses of the outer and inner sections of the pipe wall. The procedure for dividing the samples has already been described. The significance of comparative analyses of the wall sections is that the inner section represents that portion of the pipe wall which had its inner surface exposed to water; the outer section was nearest the cylinder. Thus, if appreciable amounts of the cementitious component of the concrete had been removed because of exposure to water, it would have been revealed in the comparative analyses. The significant figure in determining whether appreciable cement has been removed is the ratio of cement to calcium oxide. Variation of the calcium oxide concentration alone is not significant, since, in pipe manufacturing, the percentage of cement present in any section of the wall depends, to some extent, upon the process used. In Table 6, this cement–calcium oxide ratio is shown and it is seen to be remarkably constant in all cases. These analyses were run after the thin, chalky layer had

TABLE 6

Composition of Pipe Wall

Item	Amount—*per cent of total*									
	Sample *A*		Sample *B*		Sample *C*		Sample *D*		Sample *E*	
	Outer Layer	Inner Layer	Outer Layer	Inner Layer	Outer Layer	Inner Layer	Outer Layer	Inner Layer	Outer Layer	Inner Layer
Acid Soluble (Cement)										
SiO_2	5	3.5	4.1	4.7	4.5	4.1	3.6	4.8	3.0	3.0
Al_2O_3	1.5	1.3	0.89	1.3	1.2	1.2	1.4	1.8	1.0	1.0
Fe_2O_3	0.77	0.66	0.33	0.34	0.98	0.94	0.62	0.62	0.42	0.45
*CaO	14.8	9.7	10.8	12.1	11.9	11.1	12.7	15.6	10.0	9.8
MgO	0.77	0.56	0.23	0.28	0.60	0.58	0.68	0.93	0.48	0.46
SO_3	0.38	0.32	0.24	0.28	0.33	0.41	0.37	0.40	0.38	0.39
K_2O	0.03	0.02	0.00	0.00	0.04	0.05	0.07	0.06	0.04	0.05
Na_2O	0.00	0.00	0.00	0.00	0.02	0.01	0.04	0.02	0.01	0.01
Total	23.2	16.1	16.6	19.0	19.6	18.4	19.5	24.2	15.3	15.2
Acid Insoluble	73.3	81.3	82.3	79.4	79.6	80.6	77.7	73.2	82.8	82.7
Ignition Loss	3.5	2.6	1.1	1.5	.77	.96	2.9	2.2	1.8	2.2
Total	100.0	100.0	100.0	99.9	100.0	100.0	100.1	99.6	99.9	100.1
*Cement:CaO	1.55	1.65	1.57	1.57	1.68	1.62	1.50	1.54	1.50	1.53
	Amount—*per cent of acid-soluble portion*									
SiO_2	21.5	22.0	24.7	24.8	22.9	22.0	18.7	19.9	19.6	19.8
Al_2O_3	6.5	7.8	5.4	6.7	6.0	6.7	7.2	7.4	6.6	6.6
Fe_2O_3	3.3	4.1	2.0	1.8	5.0	5.1	3.2	2.5	2.8	3.0
CaO	63.6	60.5	65.1	63.7	61.0	60.4	65.0	64.4	65.1	64.6
MgO	3.3	3.5	1.4	1.5	3.1	3.2	3.5	3.8	3.2	3.0
SO_3	1.7	2.0	1.5	1.5	1.7	2.2	1.9	1.7	2.4	2.6
K_2O	0.13	0.15	0.00	0.00	0.21	0.26	0.34	0.25	0.27	0.34
Na_2O	0.00	0 00	0.00	0.00	0.12	0.07	0.20	0.09	0.04	0.11
Total	100.03	100.05	100.10	100.0	100.03	99.93	100.04	100.04	100.01	100.05

been removed from the pipe. Again, the removal of the cementitious component had not progressed into the wall of the pipe.

The uniformity of the cement–calcium oxide ratio, and the observed cement content of the outer and inner sections of the concrete pipe, both indicate that no significant solution of calcium has taken place beyond the thin chalky layer. Confirmation of this conclusion is further provided in the favorable results of compression tests made on some of the samples. If any significant amount of the calcium had been removed, the strength of the concrete would have been impaired. This would be of more consequence in con-

crete pipe than in a cement-lined pipe, because in a lining that blankets and protects the iron-pipe surface, the coating could be efficacious even though its calcium content were considerably reduced. Serious loss of calcium would, however, affect the strength of concrete and be of considerable importance in concrete pressure pipe.

TABLE 7

Typical Analysis of Sebago Lake Water

Item	Amount—*ppm*
SiO_2	2.9
Fe	0.05
Cu	0
CO_2	0
HCO_3	8
SO_4	7.0
Ca	4.2
Mg	0.8
Na	1.4
K	0.4
Cl	2.0
F	0
Dissolved Solids	23
Total Hardness (as $CaCO_3$)	14
Turbidity	0.7
Color	15
Avg. Langelier Index	−3.51

Portland Experience

The records of the solution effect of water on several concrete pipelines are available. Experiences with several such lines at Portland, Me., are of particular interest. Portland obtains its water supply from Sebago Lake, located about 16 miles from the city. The public agency operating the water utility is the Portland Water Dist. The lake water is extremely soft and low in mineral content, and it is used unfiltered. Judged by the Langelier $CaCO_3$ equilibrium test, this water would usually have a negative $CaCO_3$ index value, indicating considerable aggressiveness. An analysis of Sebago Lake water is shown in Table 7.

In November 1931, 15,100 ft of new 48-in. diameter concrete pressure pipe and 13,600 ft of 42-in. diameter concrete pressure pipe were placed in service in the transmission system bringing Sebago Lake water to Portland. The solution effect of this soft, aggressive water on the new pipeline was studied for over three years by Harold B. Scales (*8*), Portland Water Dist. chemist. The results (Table 8) show that, for the 48-in. pipe, very slight solution of salts from the concrete was taking place after 36 months of exposure. The solution was very slight after 35 months for the 42-in. line. In both cases, the initial rate of solution subsided rather quickly. At the time the regular sampling program was discontinued, there was a trace of increase in the alkalinity and pH of the water after passage through these lines.

In another section of the Portland transmission system, two extensions of concrete pressure pipe were made in 1949. These consisted of approximately 37,400 ft of 30-in. diameter pipe, and approximately 18,500 ft of 16-in. diameter pipe. The 16-in. line is the pipe of Fig. 1 (*C*). After four years of use, evidence of some solution of calcium was detected, and this continued after the pipe had been in use approximately five years. This pipe, when tested, showed good strengths (*see* Table 9), and tests on the concrete itself indicated that an almost impermeable layer had formed just below the $\frac{1}{32}$-in. inner coating. Water containing phenolphthalein indicator placed on the inner layer did not reach a pH of 8.2 and was absorbed in a manner resembling blotting paper.

TABLE 8
Water Quality in Concrete Mains at Portland *

Date of Test	Sample No. 1			Sample No. 2			Sample No. 3		
	Hardness *ppm*	Alkalinity *ppm*	pH	Hardness *ppm*	Alkalinity *ppm*	pH	Hardness *ppm*	Alkalinity *ppm*	pH
1931									
Dec. 1	16.7	4.0	7.1	21.4	8.0	8.2			
Dec. 8	17.4	5.0	7.1	21.4	8.0	8.2			
Dec. 15	16.7	5.0	6.9	20.7	8.0	8.2			
Dec. 22	16.7	4.0	6.9	20.1	7.0	8.2			
1932									
Jan. 12	16.7	4.5	7.0	19.4	6.0	7.3	20.1	8.0	8.1
Jan. 26	16.0	4.0	6.9	17.4	6.5	6.9	20.1	8.0	7.4
Feb. 9	16.7	5.5	6.9	18.0	5.0	7.1	20.1	7.5	7.9
Mar. 1	16.0	4.0	7.0	18.0	5.0	7.1	20.1	7.5	7.9
Apr. 5	16.0	4.0	6.9	16.7	6.0	7.1	18.7	7.0	7.4
May 5	16.0	4.5	7.0	16.7	5.0	7.2	17.4	7.5	7.7
Jun. 7	16.0	5.0	7.1	17.4	6.0	7.3	19.4	8.0	7.9
Jul. 14	16.0	4.0	7.1	17.4	6.5	7.3	18.7	8.0	7.2
Aug. 12	16.0	4.0	6.9	18.0	6.0	6.9	18.7	8.0	6.9
Sep. 14	15.5	5.0	6.8	17.4	6.5	7.1	18.7	8.0	7.5
1933									
Jan. 6	16.0	4.0	6.9	17.5	4.5	7.0	18.7	8.0	7.1
Apr. 1	16.0	4.0	6.9	17.4	5.0	7.0	18.0	6.0	7.0
1934									
Dec. 3	15.5	3.5	6.9	16.8	4.0	6.9	17.4	5.5	7.0

* Sample No. 1, Mosher's Corner, 20–48-in. diameter main; Sample No. 2, Spring Street, 48-in. diameter; Sample No. 3, Stroudwater, 42-in. diameter.

Water, dropped in the section immediately under this inner layer, stayed in droplet form or ran off, indicating the existence of an impermeable layer. When the surface below this impermeable layer was exposed, it absorbed water readily, and phenolphthalein indicator gave immediate evidence of solution of $Ca(OH)_2$.

Discussion

Various explanations have been offered and suggested for the reaction that results in the cessation of solution of calcium from cement in linings or in concrete pipe after a surface layer is formed. Sealing of the cement's pores by the formation of carbonates has been suggested. Several investigations found that through the substitution of iron precipitate in the pores, protection to cast-iron cement-lined mains was continued even after virtually 100 per cent removal of calcium from the lining. A blanketing action of the surface layer has been considered, as well as the fact that such a layer might prevent or greatly slow down the rate of diffusion. It is also possible that semi-permeable membranes are formed with a resultant osmotic effect that would inhibit the flow of water away from the cementitious matrix.

It has been shown that exposure to CO_2 gas during curing has practically

eliminated this early calcium solution phenomenon (1). This would indicate that sealing with $CaCO_3$ takes place as mentioned. It has also been found (*3, 4*) that sealing with iron salts has been an effective barrier to further calcium removal, and the analytical results and the color of the thin layer found in this investigation give some credence to this hypothesis. It is hoped that examination of additional pipeline samples and the setting up of some research work to study further the foregoing hypotheses will help to solve and explain this problem.

TABLE 9

Results of Strength Tests on Concrete Pipe Samples

Location	Age of Pipe *years*	Compressive Strength	
		Inner Section of Lining—*psi*	Outer Section of Lining, Adjacent to Cylinder—*psi*
Norfolk	5	3,425*	4,200
Portland	3	5,740	3,425
Portland†	25	6,980	6,480

* Specimen was damaged during cutting.
† Specimen was from a 48-in. concrete line also in transmission service.

Conclusions

The investigation and survey has so far shown the following:

1. Concrete pressure pipe is only slightly affected by even aggressive water over service periods of 25 years and longer; no case of failure or even serious damage to concrete pipe was found attributable to the solution effect of water on the concrete.

2. When new concrete pipe is put into use, a reaction takes place which soon stops further solution of calcium and leaves the concrete in good condition below a $\frac{1}{32}$–$\frac{3}{32}$-in. thick surface layer. This reaction as yet is not clearly understood.

3. Further study is needed to determine why concrete resists solution in waterworks service.

4. Additional study as to the effectiveness of paint-seal coats is required before results on the subject can be reported.

Acknowledgments

The authors wish to express their appreciation to W. J. McCoy, Director of Research, and O. L. Eschenour, Research Chemist, of the Lehigh Portland Cement Co., for their contribution of material and assistance in preparing this paper, and to the A. P. Smith Manufacturing Co. and members of the American Concrete Pressure Pipe Assn. for contributing samples used in this study.

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Discussion

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The test reported in this discussion was on the relative amount of leaching which took place from specimens of seal-coated and unsealed cement-lined cast-iron pipe. The duration of the test was six years, which is believed to be the longest period represented by similar quantitative data which have been obtained, and published. No direct discussion of the work of Flentje and Sweitzer is included, but the leaching test reported here is of material interest in the consideration of their paper.

History of Coating

The cement-lining of water pipe is a practice which dates back to at least about 1845, when the first cement-lined sheet iron pipe is said to have been laid in Jersey City, N.J. (*1*). Probably the first time that cement lining was used in cast-iron pipe was at Charleston, S.C., in 1922, by the late James E. Gibson (*1*). The use of small sizes of cement-lined steel or wrought-iron pipe for service lines has been common practice in the New England states for nearly 100 years.

The use of cement-lined cast-iron pipe increased quite rapidly after its introduction in 1922, and the difficulties caused by the leaching of the soluble constituents from this lining were soon realized. The efforts to reduce these difficulties led to the development of the use of a seal coat on the cement lining. The first use of such a seal coat in the US appears to have been in about 1930 by the New York City Dept. of Water Supply, under the direction of William W. Brush, then Chief Engr. Brush, however, believes that such a seal coat was used several years earlier in England. In New York City, this first seal coat was applied simply by dipping the cement-lined pipe in the same hot coal-tar dip which had previously been used for dipping unlined pipe. This practice was discontinued because it was found that the cement lining, as then made, was harmed by the thermal shock of the hot dip. Since then, seal coat has been applied at air temperature and by means of long-handled brushes or, more generally, by spray gun.

For a number of years the sole purpose of the seal coat was to eliminate or reduce the rapid and troublesome initial leaching from the cement lining. During this period the seal coat was generally not applied until after the cement lining was partially hardened and cured. It was later recognized, however, that the seal coat could assume another very useful function—that of preventing the rapid evaporation of the moisture from the freshly placed cement lining. The setting and curing conditions of the lining would thus be improved, and troublesome efforts to keep the fresh lining under humid conditions would no longer be necessary. To accomplish this , the seal coat was generally applied to the lining by spray gun within an hour or two after the completion of the cement-lining operation. This method of application is still used. The modern seal coat, then, has two distinct and rather unrelated functions: first, that of serving the foundry as a so-called "cure-assist" to seal in the moisture in the

fresh lining, and, second, serving the pipe user in preventing the rapid leaching of the soluble constituents of the lining after it is placed in service.

The seal coat, in addition to performing these two functions, must have certain characteristics. It must adhere properly to the fresh damp lining and set up properly without running. It must not at any time impart any taste, odor, color, or other objectionable characteristic to water which the pipe may carry.

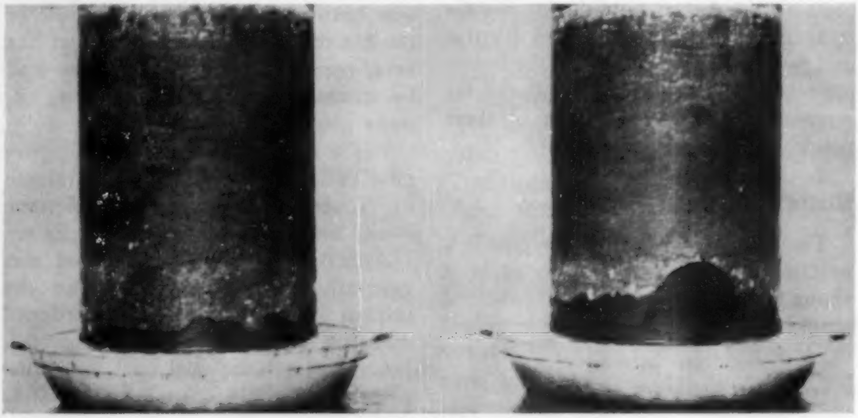

Fig. 2. Cement-Lined Cast-Iron Test Pipe

Both sections were cut from pieces of previously lined pipe. One section had been seal coated, the other had not.

Previous Tests

At about the time New York City started the use of seal coat, Frank E. Hale, then Director of Laboratories of the New York City water department, conducted some tests to determine the effectiveness of the seal coat, and to find out how long it would prevent solution from the lining. These tests were described by Hale in a paper before this Association (*1*). They are also described in more detail in several annual reports of New York City's Mount Prospect Laboratory, starting in 1930 (*2*). The tests included quantitative determinations extending over a period of about three years. Also included were tests of several seal-coating materials to determine their freedom from taste-, odor-, and color-producing characteristics.

The Gregg Company worked with the Burlington, N.J., plant of the US Pipe & Foundry Co. in the early development of seal-coating materials. Several types of material were tried out during this early period, but almost immediately the search narrowed down for the most part to the various types and blends of asphalt cut-back solutions (asphalt thinned with solvent). These have been generally satisfactory, both for the physical requirements and for their relatively low cost.

In 1947, in response to a demand for more definite data on the effectiveness and life of the seal coating, the Gregg Co. undertook the test which is the

subject of this paper, and which extended over a period of six years.

Present Test

For the present test, two 1-ft long sections of 6-in. cement-lined cast-iron pipe, shown in Fig. 2, were placed on end in separate flat dishes, with the bottoms sealed into the dish by means of paraffin wax. One of the sections was seal coated, the other was not. Each pipe was then filled with distilled water, and periodically emptied and refilled with fresh water by means of a siphon arrangement so that there would be no moving or jarring of pipes or any scouring or other disturbing effect on the interior surfaces.

The water in the pipes was tested each time for total dissolved solids. This procedure was followed without interruption for the full 6-year period of the test.

The two pieces of 6-in. cement-lined cast-iron pipe were furnished by the US Pipe & Foundry Co. from its plant at Burlington, N.J. They were selected so as to be typical of the regular production pipe being turned out by the plant at that time (February 1947). Both pieces were cut from regular full-length pieces of previously lined pipe. One of these sections had been seal coated, the other one not. The cement linings in valved pipes were produced in accordance with ASA specifications A21.4-1939 (*3*). The cement mortar consisted of one part of Type I portland cement and $1\frac{1}{2}$ parts of sand, by volume. The mortar was applied centrifugally to a nominal thickness of $\frac{3}{16}$ in. The pipes were lined about a month before the test began.

The seal coat was the Gregg Company's regular product which was furnished to the pipe company for their regular production purposes, consisting of an asphalt cut-back solution specially formulated for this purpose. It was applied to the fresh cement lining by spray gun under regular plant pro-

TABLE 10

Chemical Analyses of Water Samples

Item	Amount—*ppm*		
	Distilled Water Used for Refill	Water Samples After Fifth Year of Test*	
		Sealed Pipe	Unsealed Pipe
Alkalinity to phenolphthalein	0	0	4.0
Alkalinity—total	1.0	6.0	21.0
Free carbonic acid (CO_2)	2.0	1.0	0
Total solids	3.5	8.5	26.0
Iron and aluminum oxide (R_2O_3)	Trace†	0.5	0.75
Calcium (Ca)	0	3.9	11.5
Magnesium (Mg)	0	0	0
pH	6.1	6.7	8.8
Acid insoluble (SiO_2)	0.25	1.85	5.0

* Samples taken from test pipes at end of a regular semiweekly test period.
† Less than 0.1 ppm.

duction procedure before the 1-ft piece was cut from the original pipe length.

The water used throughout the test for filling and refilling the test pipes was a commercial grade of distilled water which was regularly furnished by one of the "spring water" companies for office drinking-water coolers. This water was regularly checked for total dissolved solids by means of an electrical-conductivity meter, usually showing a dissolved solids content of approximately 4 ppm. An analysis of a sample of this water is shown in Table 10.

The entire test was conducted at room temperature, which was recorded at the time of each set of readings and which varied between about 64°F at times during cold weather and about 95°F in the summer. It was thought at times that the fluctuation in temperature might have had some effect upon the test results, but no consistent effect of this kind is evident upon the test as a whole.

All routine determinations of total dissolved solids throughout the test were made with an electrical-conductivity bridge and a standard dip-type conductivity cell (*see* Fig. 3). The dip-type cell on the end of a flexible cord enabled the making of observations on the water in the test pipes without the withdrawal of a sample. The conductivity bridge and cell were subject to occasional calibration, and were frequently checked by readings on

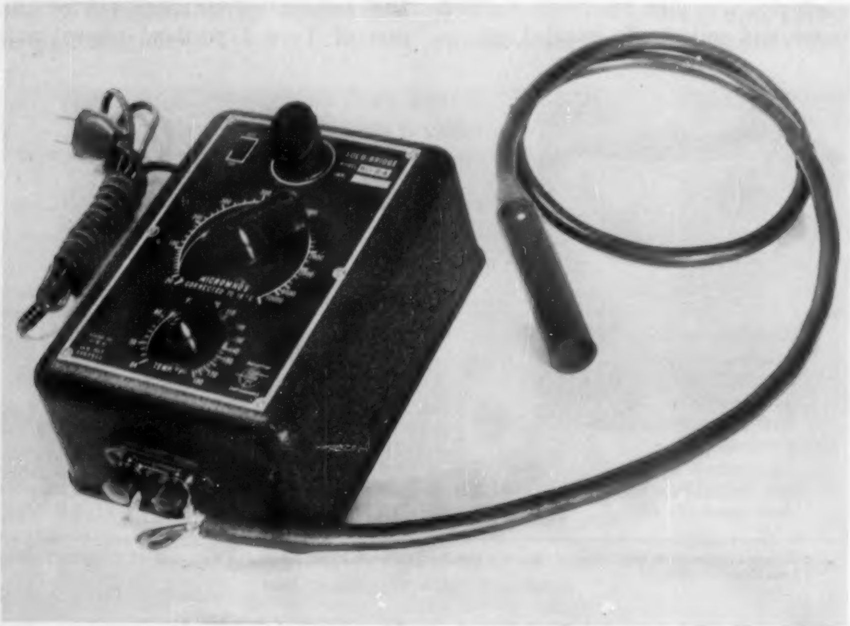

Fig. 3. Electrical Conductivity Bridge and Cell

This was used throughout the test for making determinations of dissolved solids.

the fresh distilled water. In translating conductivity readings into parts per million of dissolved solids, they were, of course, corrected for temperatures.

Procedure

The test procedure in detail was as follows. Commencing on March 11, 1947, each of the two test pipes was filled for the first time with the distilled water. Thereafter, each day for three days the water in each pipe was tested for total dissolved solids. At the end of this three-day period, the water in the test pipes was withdrawn and discarded and the pipes were immediately refilled with fresh distilled water. During the next four days no observations were made, but at the end of this four-day period, which concluded one week of test, the water in the test pipes was again tested. The pipes were then drained and again refilled to start the second week. This procedure was followed each week during the first ten weeks of the test, after which the daily readings during the first three days of each week were discontinued. Thereafter, the program consisted of alternate three- and four-day periods, the water in the test pipes being tested for total dissolved solids and the water being renewed at the end of each period. No further change in procedure was made except for such minor variations as resulted from occurrence of holidays. The text was concluded on May 7, 1953, after six years and nearly two months. This made a total of approximately 640 semiweekly test periods.

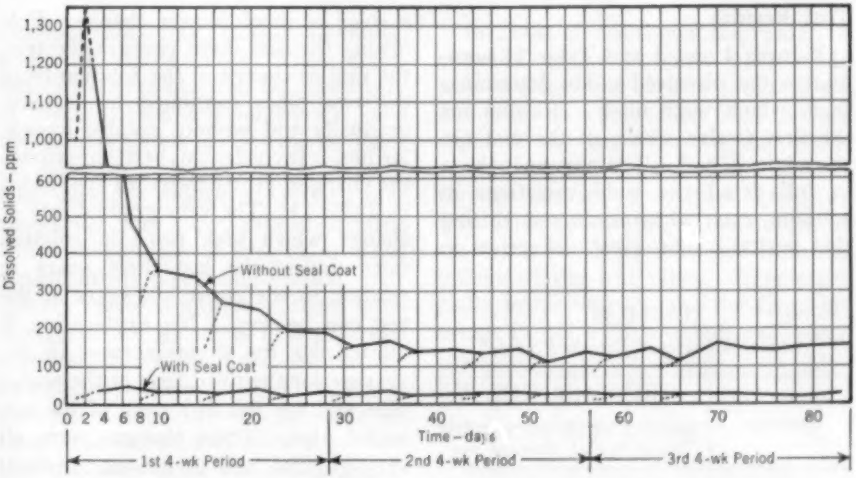

Fig. 4. Dissolved Solids Determinations for First 12 Weeks of Test

The curves are determined by actual readings taken at the end of each three- or four-day period, and the saw-tooth appearance of the lines is due to this alternating time span between readings. The short dotted lines indicate intermediate readings taken during the first three days of each of the first ten weeks.

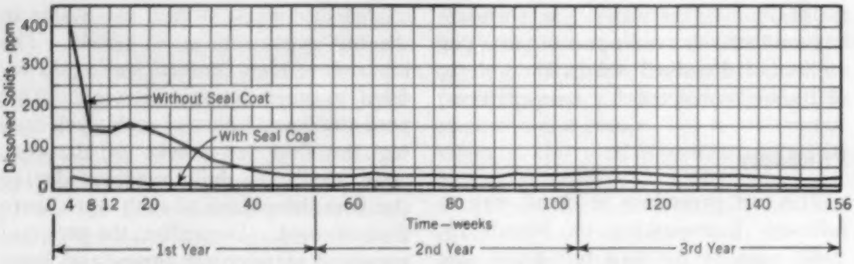

Fig. 5. Dissolved Solids Determinations for First 3 Years of Test

The reading for each 4-week period is an average of eight semi-weekly readings.

Test Results

Figures 4 and 5 and Table 11 summarize the dissolved-solids determinations which were made. Results for the first twelve weeks of the test are shown in Fig. 3. The curves indicate in full detail the wide variations in solution rate which occurred during this period. The great difference in the solution rate of the lining with seal coat and that of the lining without seal coat is indicated by these curves. A condensation of results for the first three years is shown in Fig. 5.

TABLE 11

*Annual Averages of Dissolved Solids**

Test Year	Dissolved Solids—*ppm*	
	Sealed Pipe	Unsealed Pipe
1	14.3	114
2	7.4	30.2
3	8.7	26.9
4	7.0	21.5
5	7.0	22.6
6	6.8	18.8

* Each figure is the average of the 104 readings taken during the year.

It is seen that, after about the first 84 days, the solution rate had reached a stage of much slower change. Following the first three years of the test, the rate of change in the solution from the two pipes continued to decrease gradually and without notable irregularities. In order to best summarize the changes, yearly averages are shown in Table 11. The very gradual rate of change which took place in solution rates during the last three years in relation to the entire six years of the test can be seen. No explanation is offered for the slight increase in the average for the third year of the sealed pipe and for the fifth year of the unsealed pipe. These changes were all very gradual, and no reason for them was noted.

It may be seen that, at the end of the six-year period, the difference in rate of solution between the sealed and unsealed linings was still such that, at the rate at which they were converging, it might have taken as much as 15 or more years of testing before the two specimens would be leaching at the same rate.

In addition to the above observations, at the end of each of the first three days of the test, samples were taken from the test pipes and sent to a laboratory for determinations as to

TABLE 12

*Alkalinity and Soap Hardness During First Three Days of Test**

Item	Amount—ppm					
	Sealed Pipe			Unsealed Pipe		
	1st Day	2nd Day	3rd Day	1st Day	2nd Day	3rd Day
Total alkalinity†	10	10	15	730	880	900
Caustic alkalinity†	0	0	0	690	840	840
Total soap hardness†	5	5	7	616	735	735
Total solids, by conductivity	17	22	33	995	1,340	1,170

* The water was not changed during the 3-day period.
† As $CaCO_3$.

the total alkalinity, caustic alkalinity, and total soap hardness. These determinations were made in the laboratory of the US Pipe & Foundry Co., and the data reported are shown in Table 12, together with the total solids content already discussed. The table shows the very rapid rate of solution which takes place at first in unsealed cement-lined pipe, and which may quickly reach saturation if there is no change of the water, as in a dead-end pipeline. It will be noted that for the unsealed pipe there is very little, if any, increase in alkalinity and hardness between the second and third days, and that the total solids showed a considerable decrease between these days. It is believed that this is because the concentration of the solution reaches a point where precipitation occurs. This effect was noted visually in a previous test in which the water in the test pipes was not changed at all during the test. Uncertainties resulting from this precipitation effect caused the abandonment of the test and the decision to change the water twice a week in the present test. It is not believed that precipitation influenced any of the test results after the first three-day period, due to the rapid decrease in solution rate.

In Table 10 are shown the results of chemical analyses which were made after the test had been in progress for five years on water taken from the test pipes at the end of a regular semiweekly fill and draw period. Except for this one set of analyses, no effort was made to determine the nature of the solids which were leached from the linings of the test pipes. It is especially interesting to note the large increase in pH of this unbuffered water from the unsealed lining, even after five years of leaching.

Effects on Pipe Lining

The appearance of the interior surfaces of the test pipes during progress of the test was not recorded. At present, about one year after conclusion of the test, the test pipe having the seal-coated lining is still full of water, and the appearance of the interior of this pipe has changed very little, if any, from what it was at the beginning of the test in 1947. None of the seal coat has peeled, cracked, or checked, and none appears to have been lost. There is no deposit of scale, silt, slime, or anything else which is visible or which can be wiped or scraped off. Although the seal coat material has not changed in appearance, it has lost

much of its toughness and strength, and it can be removed by the fingernail, leaving the cement lining bare but still stained black. Fig. 6 gives some idea of the appearance of this pipe at present. The dish in which the pipe had been originally set has been replaced by a metal container.

The pipe in which the lining had not been seal coated was allowed to dry out soon after the completion of the test. Fig. 6 shows this pipe as it appears now. The cement lining is mostly covered by a thin brown deposit which has peeled off in some spots. The lining itself appears to be intact.

Fig. 7. Pipe Without Seal Coating After the Test

The flaking and chipping on the interior of the pipe is not the lining, but a thin brown deposit which has begun to peel.

Conclusion

There are two observations which appear to be outstanding from this test. One is the fact that under the particular conditions of the test, substantial leaching from the unsealed cement lining still persists after six years of leaching, and the data indicate that this leaching would continue at a gradually reduced rate for much longer. The other observation is that the asphalt seal coating still is effective and performing its function after six years. Until this test was made, it had geen generally thought that the life of the coating was not this long.

Fig. 6. Seal-coated Pipe After Testing

The coating still appears good, but it has lost much of its toughness.

It may be pointed out that the results of this test should be applied quantitatively to other cases with some care. One reason is that this test was limited to the comparison of only two specimens, and while every effort was made to have these specimens representative of a standardized operation, some variation in such a product is to be expected. Secondly, the test was conducted under only one set of conditions as regards character of water, temperature, change of water procedure, and other details. Any other actual case would probably be different with respect to some or all of these conditions, and the results would be altered quantitatively. This test, therefore, should be considered as indicative only of what *may* result in any other case, and not what will necessarily take place.

Acknowledgment

This six year test was conducted in the laboratory of the Gregg Co., Riverton, N.J., under the direction of A. Pierce Gregg, President. The writer did not personally carry on any of the work of the test, but he was closely associated with those who were doing it, and familiar with the work at all times. The analyses in Table 10 were made at the South Pittsburgh Water Co.

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This discussion is based on information collected in connection with studies on the nature and seriousness of leaching from concrete pipes in Portland, Me. The writer's interest in this problem arises from the fact that his firm served as consulting engineers to the Portland Water District.

About five years ago the Portland Water District constructed a 30-in. reinforced concrete pipeline approximately 37,400 ft long, and a 16-in. reinforced concrete pipeline approximately 18,500 ft long. In the summer of 1953 pH values of 8.5 to 9.2 were noted in samples taken from the downstream ends of these pipelines. The pH value of the water at the upstream end was approximately 6.9. The significant change in pH values indicated leaching of free lime. Subsequent analyses of the water indicated an increase in total alkalinity of about 2.5 ppm throughout the length of the 30-in. line. Analyses made of the solubility of powdered specimens of concrete similar to that used in the two lines showed that the increase in weight of total alkalinity in the water in the pipelines was about equal to the decrease in weight of the solid pipe wall. About 95 per cent of the solid material leached from the pipe wall was found to be lime from the hydrated cement. The remainder was silica and alumina, also from the cement. The rate of leaching was computed from the increase in alkalinity and the average rate of flow in the 30-in. pipeline, and was found to be about 0.006 in. per year expressed in terms used in the field of corrosion of metals.

At first it appeared that a rate of leaching of 0.006 in. per year did not warrant serious concern, particularly when compared with known rates in the corrosion of steel, which are much higher. When it is realized, however, that it is only the lime which leaches out, and that the lime in the hydrated cement of the concrete (which is the bonding material and completely soluble) occupies only about 20 per cent of the volume, it is evident that the rate of penetration of the leaching process was about 0.03 in. per year at the time the measurement was made. Our studies indicated that the leaching had penetrated to a depth of about 0.2 in. during a period of about three years. This is a very substantial penetration for a concrete lining only 1 in. thick.

One length of the 16-in. pipeline was removed for examination and for chemical and compressive strength tests. The compressive strength tests indicated a loss in strength of approximately 30 per cent for the concrete on the interior face. These tests were made on $\frac{1}{2}$-in. thick specimens from the interior and exterior faces of the pipe, and the results recorded are the average strengths of three specimens from each face. These figures are in marked contrast with the results reported by the authors for compressive strength tests made on specimens taken from the pipe shown in their Table 7. This contrast may be taken as an indication of the unreliability of conclusions based on compressive strength tests of a small number of specimens.

The authors state that in practically all cases the solution effect of water on the cement compounds has been found to disappear in a relatively short period, and they cite as reference a symposium on cement-lined water mains published in the Dec. 1933, *Journal*. The writer finds no confirmation of the authors' statement in this reference. In fact, on p. 1733 of this reference, Leonard P. Wood states that in cement-mortar pipe linings, the rate of solution rapidly diminishes, but if the water is corrosive to calcium carbonate, the solution of the lime probably never entirely stops until, if the lining is sufficiently thin, the lime is all leached out. Also, on p. 1759, John R. Baylis states that an examination of some cement-lined pipe nearly 50 years in service showed that practically all of the calcium had been dissolved from the lining, but it still remained in place on the pipe and was giving very good protection, although there was some corrosion.

The graphs presented in P. S. Wilson's discussion show that, after six years, leaching is still continuing from the cement lining of cast-iron pipe specimens, both with and without a seal coat. The seal coat is shown to be fairly effective in reducing the rate of leaching, but nevertheless the rate of leaching in both specimens has not greatly decreased, even at the end of a six-year period.

Through the courtesy of the Gregg Co., the writer and his associates were given the opportunity to analyze the data shown by Wilson, which had, at that time, extended over a five-year period. The studies showed that the cement lining without a seal coat was leaching at the rate of about 0.0005 in. per year and that the cement lining with the seal coat was leaching at the rate of approximately 0.0001 in. per year. The seal coat had thus reduced the rate of leaching by about 80 per cent. These rates of leaching seem to be quite small, but it must be remembered that cement-mortar lining is only about $\frac{3}{16}$-in. thick, and not much lime is available in such a thickness for leaching. The writers' studies showed that the leaching layer had penetrated to the full thickness of the mortar in less than a year for the lining without the seal coat, and in about six months for the lining with the seal coat. The rate of leaching for both specimens was high initially, but decreased rapidly to a very low value after about six months, when the leaching layer extended through the full thickness of the lining. During the five-year period, about 7 per cent of the hydrated cement was leached out of the lining

without a seal coat, and about 1 per cent from the lining with a seal coat.

In drawing their conclusions, the authors placed great weight on the results of visual examinations, chemical analyses, and compressive strength tests of specimens taken from existing pipelines. The chance that such specimens are representative of the pipelines as a whole is very small. On the other hand, an increase in alkalinity throughout the length of a pipeline is representative of the performance of the entire line insofar as leaching is concerned. If leaching is greater in one section of the line than it is elsewhere, which might well be the case, the strength of the section undergoing the greatest rate of leaching might be seriously impaired.

Some of the authors' conclusions are based upon tests of specimens taken from reinforced-concrete pipelines which have been in service for about 25 years. The authors claim that these tests indicate that no measurable deterioration of the pipe has occurred. The writer believes that these conclusions are not sound. No data are available on the compressive strength of the concrete at the time of laying the 25-year old pipelines, and it is therefore not possible to say that there has been no reduction in strength due to leaching, even though no consistent differences in strength were observable between inside and outside specimens. It is also not possible to say that the test specimens were representative of the pipe as a whole.

In the writer's opinion, the increase in alkalinity of the water flowing in a pipeline is the most conclusive evidence of leaching. This evidence shows that the rate of leaching of thin-walled pipelines is great enough to warrant the serious attention of the water works industry to the problem of leaching and to the discovery of remedies for this problem.

The writer, then, does not share the confidence of the authors that thin-walled reinforced-concrete water pipes will be durable over long periods of years. He believes that some remedy must be found to retard substantially the rate of leaching if reinforced-concrete pipe is to be competitive in service life with cast-iron pipe.

Authors' Closure

The authors welcome T. R. Camp's criticisms. They believe the importance of the subject warrants such discussions and they encourage comments by other interested parties.

The authors concur with Camp in some of the statements made in his discussion, but they feel there are several points of disagreement which require comment.

In questioning the longevity of concrete pipe, Camp appears to have based his uncertainty on a series of analyses of a single water. Furthermore, in subsequent paragraphs, he takes issue with the authors for drawing conclusions from the results of visual examinations, chemical analyses, and compressive strength tests of specimens taken from existing pipelines. He further states that it should be recognized that the chance that such specimens are representative of the pipelines as a whole is very small. The authors

submit that there is no better nor more thorough method of examining and studying pipe than by visual, chemical, and physical means, and that, because the samples were taken at random, at points selected by disinterested parties, the likelihood of their being representative is as good as can be obtained short of removing the lines from service and sampling each length of pipe.

Camp's objection to the limited number of compressive test samples seems warranted. However, other than using such tests for corroborative evidence, the authors included them only as secondary information. Compressive tests on $\frac{1}{2}$-in. samples in which the aggregate itself is $\frac{3}{8}$ in. in size may, it is agreed, be almost worthless, regardless of the number of samples.

The authors still feel that it is no coincidence that in each of the five pipe samples reported upon (which came from widely separated locations and which were exposed to waters of varied character for long and short periods of time) the concrete below the very thin chalky layer found on the inner surface of each specimen was sound and of good strength.

Study of this problem from both theoretical and practical aspects is currently continuing and the authors hope that final judgment of the soundness of their conclusions may be reserved until these results are at hand, or until other actual test data can be presented.

Effects of Physical Environment on Cast-Iron Pipe

—Andrew Baracos, W. D. Hurst, and R. F. Legget—

A paper presented on Jun. 15, 1955, at the Annual Conference, Chicago, by Andrew Baracos, Asst. Prof., Civ. Eng. Dept., University of Manitoba, Fort Garry, Man.; W. D. Hurst, Chairman of Comrs., Greater Winnipeg Water Dist., Winnipeg, Man.; and R. F. Legget, Director, Building Research Div., National Research Council of Canada, Ottawa, Ont.

UNUSUALLY severe soil conditions in the Greater Winnipeg area have resulted in numerous and expensive failures in the municipal water distribution system. The consequent economic loss to Winnipeg is estimated to have exceeded $1,000,000 in the past 20 years. For a system consisting of approximately 395 miles of 4-in. to 36-in. diameter mains, having 55,000 services and 7,000 valves, and serving a population of 244,000, these maintenance costs assume major proportions (*1, 2*). During 1954 alone, about $96,500 was spent on maintenance of mains, $90,000 on maintenance of services, and $55,000 on maintenance of valves. Earlier studies had determined that corrosion caused rapid deterioration of cast-iron pipe and valves in as short a time as 12 years. Lead service pipes, too, had failed in relatively short periods in the corrosive soil. It had been suspected that pipe thus weakened by corrosion often failed under the induced stress caused by the shrinking and swelling of supporting and covering soils.

Previous Research

Water main failures studied in the past chiefly as a problem in chemistry had brought significant results. As early as 1921 it was established that electrolysis, such as that caused by stray currents from street railways, was not the only corrosive factor, and that extensive corrosion was observed in areas remote from possible stray currents (*3, 4*). It was also recognized that the soluble salts of sodium, magnesium, and calcium are among the chief causes of the corrosive action of Winnipeg soils. The corrosion results when underground water containing these dissolved salts produces graphitic softening of cast-iron pipe. The same salts were found to be detrimental to concrete pipe. In 1919 it was discovered that a recently completed 96-mile concrete aqueduct servicing the Greater Winnipeg Water Dist. was being attacked externally and was rapidly deteriorating. The investigation of this action was instrumental in the development of alkali-resistant Type 5 cement by T. Thorvaldson of the University of Saskatchewan and the late A. Fleming of the Canada Cement Co. The alkali resistance of steam-cured concrete was also verified.

The prevention of pipe corrosion by the use of protective coatings and wrappings proved to be impractical because of the high costs or the extreme care required in placing the pipe to

prevent damage to the coating. In recent years, corrosion-resistant steam-cured asbestos-cement pipe has been extensively used with partially satisfactory results (*5*). The lighter Class 150 asbestos-cement pipe, having 6-in. or smaller diameter, is no longer used by Winnipeg because it was found to be subject to transverse cracking near the mid-length of the pipe section. Similar failures had been observed in both corrosion-weakened and new cast-iron pipe. This seemed to indicate that mechanical action was an important factor in the failure of both the asbestos-cement and the cast-iron pipe. To overcome such breaks in asbestos-cement pipe, a sand bed and cover have been utilized and blocks are no longer used for supporting the pipe.

Present Investigation

In 1947, because of the economic losses to Winnipeg and to all of western Canada resulting from common failure problems, Winnipeg's city engineer discussed the water main failures with the director of the Building Research Div., National Research Council of Canada, and asked that the council assist in finding methods of overcoming some of the difficulties. (The National Research Council is not a department of government, but is a public agency supported by funds granted by federal parliament.) Cooperative research in Canada involving federal, provincial, municipal, and private organizations has had many successful precedents (*6*), and it was therefore not unusual that a joint research project to investigate the water main failures was initiated by the Building Research Div., Winnipeg's engineering dept., and the civil engineering dept. of the University of Manitoba.

The studies were not begun immediately. The first delay was caused by a serious problem which arose in connection with trolley bus operation on Winnipeg streets, causing vibrations which were transmitted through the soil to adjacent buildings. This problem was jointly studied (*7*). The 1950 flood of the Red River, in which a large part of the city was inundated, necessitated a study of damage to foundations. Although these studies were not part of the water main failure studies, they indirectly contributed to the investigation. Valuable information (*8*) was obtained regarding the mechanical action of Winnipeg clays, leading to the decision to study the effects of this action on buried pipe. The studies on water main failure were finally begun in the summer of 1953.

It was known that the cast-iron water main failures were primarily a problem in chemistry. After consultation with the Applied Chemistry Division of the National Research Council, however, it was established that the corrosion problem was similar to that encountered in many other places and that the principles elucidated elsewhere were probably applicable in the Winnipeg area. To investigate the corrosion further meant a duplication of research performed at other centers, such as the Chemical Research Laboratory of the Dept. of Scientific and Industrial Research in the United Kingdom, and the US National Bureau of Standards. The present investigation was therefore limited to those features which resulted from the physical action of highly plastic clays on water mains, and which intensified the failure action. It was felt that these features might explain certain irregularities observed in the earlier studies. Corrosion was not always accompanied by a high sul-

fate content in the soil and recent research elsewhere had indicated that physical factors such as temperature differentials between the pipe and the soil and stress differences in adjacent pipe sections, as well as the chemical action of sulphate-reducing bacteria (*9*), may also be causes favoring corrosion. A study of the physical environment of buried pipe seemed advisable.

Water Department Records

The water works branch of the city's engineering department has kept accurate records of all repairs to its system and has attempted to ascertain the cause of all pipe failures. From these records it was possible to determine the monthly rate of failures attributed to "cracked-pipe," a term used to describe pipe which has cracked transversely near the mid-length and where flexural failure is suspected.

Figure 1 shows the number of failures per month attributed to "cracked-pipe," for the years 1948–1953. Also shown are monthly mean air temperatures, precipitation, and approximate depth of snow cover. There is a definite cyclic pattern to failure occurrences, with September and January having the highest tolls, and it would seem that seasonal soil changes have a direct bearing on pipe failures. Seasonal volume changes in Winnipeg soils have been observed and measured (*10, 11*).

Soil Conditions

Swelling and shrinking of Winnipeg clays have been responsible for considerable damage to foundations. These volume changes occur seasonally and can be demonstrated in laboratory and field tests. Recent measurements taken by special equipment developed at the University of Manitoba's civil engineering department show that the ground surface can rise and fall approximately 2 in. over a period of one year. In measurements taken 6–12 ft under the ground surface similar movements were observed, although the magnitude of rise or fall became less as the depth increased. During the 1950 flood, building foundations at shallow depths were observed to rise as much as 4 in. because of the swelling which accompanied increased moisture content in the supporting clays. At the University of Manitoba it was found that, during winter, soils at a depth of 4 to 8 ft can shrink. This action is believed to be caused by freezing of the soil nearer the surface, which draws water from the lower depths to form ice lenses. Percolation of surface water into the soil is negligible during these winter months, because the ground is frozen, and because precipitation is in the form of ice and snow. The reduced moisture content at the lower depth results in shrinkage, which is greater than the expansion caused by ice lensing. On the basis of soil mechanics the swelling and shrinkage of Winnipeg clays is readily explainable.

Briefly, the soils in the Greater Winnipeg area consist of highly plastic and stratified lacustrine clays and silts overlying consolidated and cemented subglacial till, found at a depth of 40 to 60 ft. The lacustrine clays are often overlain by a few feet of more recent fluvial silts of low plasticity (locally described as yellow clays) organic soils or clays which have been modified by weathering.

Shrinkage and swelling have been associated with the lacustrine clays which form two distinct layers. The upper layer (locally described as

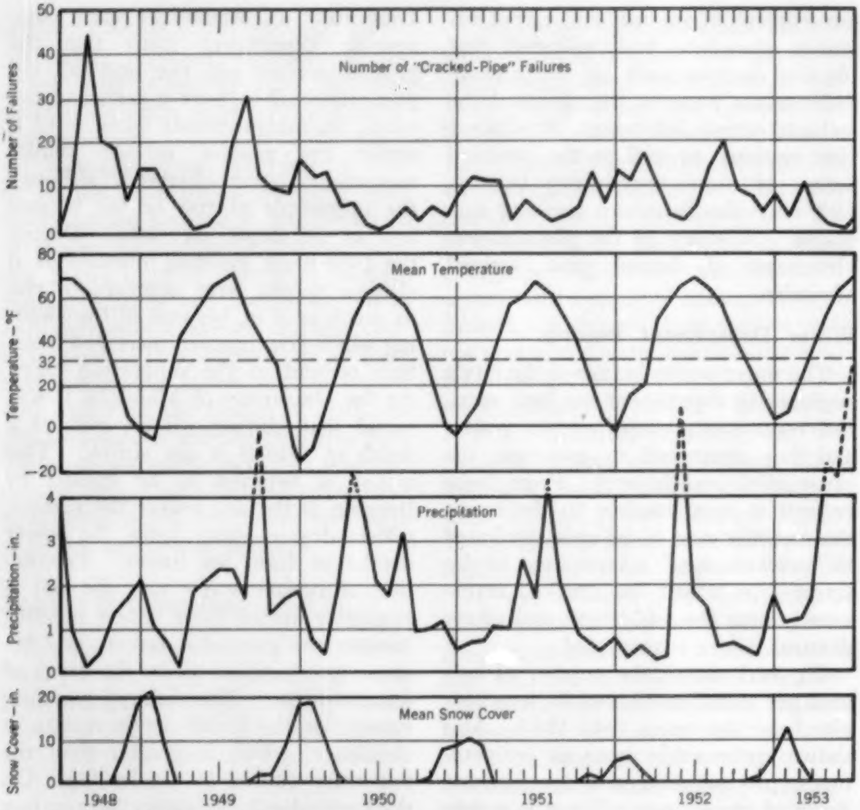

Fig. 1. Monthly Mean Snow Cover, Mean Temperature, Precipitation, and Number of "Cracked-Pipe" Failures, July 1948 to August 1953

Because they affect soils and backfills, seasonal conditions are closely related to yearly "cracked-pipe" failures.

"chocolate clay"), having a brown to gray-brown color, has liquid limits ranging from 60 to more than 100. A limited number of analyses show that as much as 30 per cent of the solid content of this clay is montmorillonite, a very active clay mineral. Swelling pressures up to 20 tons per square foot have been developed in the laboratory on undisturbed samples which were first allowed to desiccate and were then rewetted. Swelling pressures of one ton per square foot are not uncommon when water is added to undisturbed samples at natural moisture contents. In many areas of Greater Winnipeg, water mains have to be placed in this type of soil, which is found at depths of 5–20 ft.

The lower layer of lacustrine clay (locally described as "blue clay") is gray to blue-gray in color and has somewhat lower plasticity. Its liquid limits generally do not exceed 60, and it has a softer consistency. Swelling and shrinking do not normally occur

in this material as it is generally found below the zone of seasonal moisture variation.

Preliminary Considerations

The city records showed that, for the period 1940–49, there were 1,667 breaks in cast-iron pipe in the distribution system. Of these, 36 per cent were caused by "cracked pipe." For the period 1932–51, a total of 119 breaks occurred in asbestos-cement pipe, of which 21.8 per cent were classed as "cracked pipe." The smaller number of breaks in the asbestos-cement pipe reflects the limited quantity of this pipe in service at that time.

The percentages of "cracked-pipe" failures are significantly high. That such failures occurred in larger numbers during September and January suggested a correlation with the seasonal volume changes observed in Winnipeg soils. In particular, a correlation was suggested between times of peak failure occurrence and the dried-soil conditions existing after a hot summer or just prior to the spring thaw, as indicated by the university tests. Instrumentation was therefore devised to measure pipe displacements in the soil, soil temperatures, and pipe strains over a period of time, and to investigate the possibility of such a seasonal correlation.

"Cracked-pipe" failures, similar to those occurring in the smaller sizes of Winnipeg mains, have received consideration in the past. The ASA committee A-21.1, in preparing its cast-iron pipe manual *(12)*, emphasized the effects of external loading on pipelines and stated that those effects must be considered if safe design is to be obtained. Backfill and surface loads cannot be ignored any more than the stresses caused by internal pressure and water hammer effect. Nor are the stresses caused by the external loads independent of the strength and elastic properties of the pipe itself and the method of laying it.

Methods of Laying

Committee A21.1 investigated the following methods of laying pipe: *A*, pipe laid in a flat bottom trench with untamped backfill; *B*, pipe laid in a flat bottom trench with tamped backfill; *C*, pipe laid on blocks with untamped backfill; *D*, pipe laid on blocks with tamped backfill; *E*, pipe laid in a shaped bottom trench with untamped backfill; and *F*, pipe laid in a shaped bottom trench with tamped backfill.

It was demonstrated that laying conditions for pipe *C* caused the most severe stress in buried pipe, especially pipe of small diameters. To check on practices employed in laying pipe in Winnipeg, an examination of past specifications was made.

From about 1900 until about 1934, cast-iron bell-and-spigot pipe was used exclusively for the construction of city water mains. The pipe was supported on blocks 10-in. wide, at least 6-in. in depth, and extending the full width of the trench. The blocks were placed at the bell-and-spigot joints. Backfilling specifications called for the thorough ramming of 8-in. layers around and over the pipe until the trench was filled.

The first lengths of steam-cured asbestos-cement pipe were installed in 1932. In order to ensure that the manufacturer's guarantee would be honored, the pipe was laid according to the manufacturer's recommended procedure, which advocated wooden block supports placed at a distance of 0.208 L from the ends of the pipe, L being the length of the pipe. It can

be shown that, for a pipe acting as a simple beam, such support gives the least bending stress under conditions of uniform loading. Additional advantages derived from the use of the blocks were faster assembling and the ease with which the fill could be tamped on the underside to provide uniform support for the pipe. Moreover, the couplings would be kept off the ground during laying.

This method was followed from about 1934 to 1948. Field crews without proper authority applied the practice to the laying of cast-iron pipe, not realizing that the joint in this type of pipe imparted a certain continuity to the pipe sections, thus invalidating the block-spacing formula. From time to time, the inspection staff also found that the specified tamping was not always faithfully carried out, largely because of the character of the available labor.

It may be seen, then, that a very large percentage of Winnipeg's water mains had been placed using blocks, either in accordance with the manufacturer's recommendations, or because of the inadequate knowledge concerning the subject during the earlier years.

It is interesting to note that, in about 1950, the manufacturers of the asbestos-cement pipe altered their specifications and recommended the omission of the wooden blocks, except in unstable soils, for all pipe having diameters smaller than 12 in. This action apparently confirmed the city's observation that their recommended laying methods had not proven satisfactory.

In 1951 the city engineering department, in concurrence with the asbestos-cement pipe manufacturer's representatives, decided that changes in laying specifications were necessary. Wooden block supports were considered detrimental and were not to be used at any time during construction. The cost of constructing in the clay an effectively formed bed conforming to the required grade was exorbitant. (In the manufacturer's earlier specifications, the formed bed was considered to be an ideal form of pipe support.) The use of sand offered the most practical and least expensive method of obtaining the required bedding for the pipe. In this method sand is introduced into the trench prior to laying the pipe and brought to the desired grade so that when the pipe is placed in position, it can be bedded directly into the sand. In 1953, instructions were issued to the effect that cast-iron water pipe was to be laid in exactly the same manner as the asbestos-cement pipe.

Beginning the Study

The writers suspected that the swelling and shrinking properties of the Winnipeg clays intensified the severity of the pipe stresses caused by block supports. It was possible for the blocks or the bed supporting the buried pipe to be lifted by the swelling which accompanied increased soil moisture content, since earth pressures causing the pipe to push against the backfill are theoretically greater than those caused by the backfill pushing downward on the pipe. The increased moisture content of the supporting clays could result from water percolating through the backfill, which would be more permeable because of its disturbed condition. Similar percolation of water through backfill around basement walls had caused damage to foundations, sometimes causing basement floors to rise as much as 4 in. Such vertical movements in soils could well cause the failure of corrosion-weakened pipe.

It was therefore decided to develop instrumentation to measure the differential vertical movement of water mains. Longitudinal strain measurements were proposed using electric strain gages. Since frost penetration is an important factor in the behavior of the backfill, thermocouples were installed to obtain ground temperature measurements. Three methods of supporting the pipe in the test sections were tried and more methods will be tried in the future. Pertinent tests were also performed on soils from the three sites now under operation.

Test Installations

Test Installation *A* was made at a site where previous performance of an existing cast-iron main indicated highly corrosive and mechanically active soils. During the period 1925–52, 13 breaks had occurred in an 800-ft length of this pipe. Five of these breaks had been attributed to corrosion, seven to "cracked pipe" in corrosion-weakened sections, and one to miscellaneous causes. Very high shrinkage and swelling properties were indicated for the supporting soils by a liquid limit of 96.8, and a plasticity index of 55.5. Increased demand had necessitated new pipe of larger diameter.

The test installation consisted of approximately 400 ft of 6-in. diameter Class 150 cast-iron pipe, and 400 ft of 6-in. Class 200 asbestos-cement pipe placed at a depth of 7 to 8 ft. Although, normally, asbestos-cement pipe would have been used for the replacement, the cast-iron pipe was installed because it permitted the use of electric strain gages which could not be attached to the asbestos-cement pipe and be satisfactorily waterproofed. Also, with the cast-iron pipe, a special plastic tape wrapping could be tested for corrosion prevention.

The pipe was installed during December 1953 in extremely cold weather. Excavation was made using a series of shored open pits 6-ft long, connected by 4-ft long tunnels. The pipe was laid on wooden blocks placed 12–18 in. from the ends of each 6-ft length. Backfill was pushed into the trenches using a tractor and was manually spread into the tunnels. The frozen condition of the backfill precluded any compaction under or over the pipe. In the spring, considerable fill had to be placed in the trenches because the backfill had consolidated and left depressions. This installation was used as an experimental prototype in developing and checking all instrumentation.

Test Installation *B* was a 400-ft section located in a new residential development, where tests indicated high soil swelling and shrinking properties. The installation consisted of 4-in. cast-iron pipe installed in a residential bay (6 in. is the minimum size laid in ordinary streets), at a depth of 7–8 ft, supported by blocks on highly plastic clay. The trench was excavated by a trenching machine using conveyor buckets. The top 6 ft of excavation were predominantly in silt and silty clay. The wooden blocks were left in place and sand backfill was placed around the pipe to a depth of 6 in. Backfill material consisted of the excavated clay and silty clay in a well broken-up condition and was pushed into the trench using a tractor.

Test Installation *C* was similar to Installation *B* except that sand backfill was not used and the excavation was made with a backhoe. The use of this equipment resulted in the excavated soils being in large pieces. The weather permitted laying the pipe in

relatively dry trenches, and a tractor was used to push the backfill into the trench.

Vertical Movement Gages

Rods were supported on the pipe and extended to the ground surface through sleeves, with clearance to permit free movement. A removable cover at the top of the sleeves and grease packings at the top and bottom prevented water from entering. A similar rod was supported on undisturbed soil at a depth of 12 ft, and this was used as a reference datum for checking elevations at the top of the rods. The 12-ft depth was selected on the basis of the university tests which showed that, locally, this depth was relatively free of seasonal soil movements. Details of these pipe movement gages are shown in Fig. 2.

In Installation *A*, the gages were placed on four consecutive lengths of pipe. In Installations *B* and *C*, the gages were placed on 5 consecutive lengths. A further improvement in these two installations was a deep bench mark supported at a depth of about 30 ft, although a much shallower depth would have been satisfactory. This bench mark was placed to determine whether such a 30-ft deep rod could be used to establish a satisfactory bench mark in Winnipeg soils. It had been specially developed by the

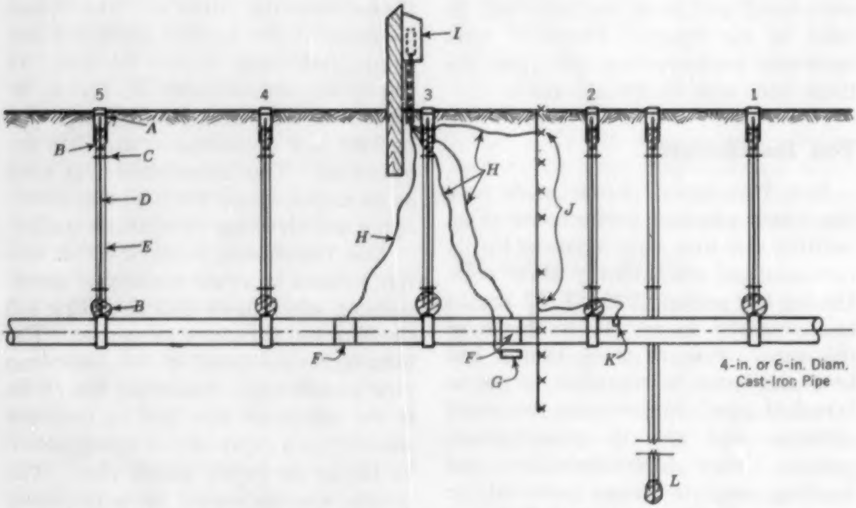

Fig. 2. Schematic Representation of Typical Test Installation

Layouts similar to this were used in each of the three installations. Letters A–E *indicate parts of the vertical movement gage:* A—*removable cap;* B—*grease packings;* C—*centering screws;* D—*rod; and* E—*sleeve. Other material is shown as follows:* F—*electric strain gages (water-proofed);* G—*compensating electric strain gage in waterproofed container;* H—*electrical leads;* I—*terminal box and selector switch;* J—*thermocouples;* K—*thermocouple temperature well; and* L—*deep benchmark in undisturbed soil.*

Building Research Div. for determining an elevation datum not subject to vertical soil movement, an essential factor in the division's soil and foundation studies. Readings on the bench mark and the vertical movement gages were carefully taken with an engineer's level.

Electric Strain Gages

The use of electric strain gages for measuring strains in buried pipe presents many difficulties. Considerable time was spent in devising methods of waterproofing the gages, which are extremely sensitive to moisture. For Installation *A*, the gages were waterproofed after being attached to the pipe, by using a plastic tape covering sealed with a self-vulcanizing synthetic rubber compound. The electrical leads were placed in a plastic hose. After the pipe was installed, gradual deterioration in the gages was indicated by the decrease in electrical resistance between the gage and pipe, showing that moisture had entered there. In Installations *B* and *C*, the gages on the pipe were covered by a thin copper sleeve which was packed with grease. This proved a very effective means of moisture-proofing. Compensating gages on nonstressed specimens of pipe, which are a necessary part of the instrumentation, were placed in separate water-tight containers and buried adjacent to the pipe. Bakelite-type electric strain gages were used in preference to paper-backed gages because of their superior long-period performance. For measuring longitudinal strains, the gages were placed all around the pipe, parallel to the longitudinal axis, at mid-length of a pipe section. A thermosetting cement was used to attach the gages to the pipe, which had been lightly machined to expose a clean metal surface. On Installation *A*, the gages were used on one length of pipe only. In Installations *B* and *C*, the gages were placed on two adjacent lengths of pipe. Initial strain readings were taken after the pipe was placed, but before backfilling. The readings were taken by connecting the necessary instruments to the terminal box, which was equipped with a double-contact rotary selective switch.

Thermocouples

Copper-constantan thermocouples, for measuring soil and water temperatures, were installed at various depths adjacent to the buried pipe. In the pipe in Installation *C*, they were placed in a temperature well. The electrical leads were taken to the terminal box and connected to a double-contact rotary selector switch. A potentiometer was used for taking the readings.

Soil Tests

Moisture content samples and bulk samples of soils underlying the pipe and of backfill were obtained. Plastic and liquid limit tests were performed, and they confirmed the high mechanical activity of the soils and their susceptibility to shrinking and swelling with moisture variations. These values were particularly high for the soils supporting the pipe at the bottom of the trench. Records were taken during the laying of the pipe and at frequent intervals thereafter.

An overall picture of a typical installation is shown in Fig. 2.

Test Results

The vertical movement gages proved extremely informative. Some typical ranges of movement are shown in Fig. 3. Test Installation *A* showed that the

pipe can move upward as much as 2 in. when "trench and tunnel" methods of excavation are used. The large upward movement here can be attributed to poor backfilling. This results in improper compaction, allowing surface waters to percolate into the trench and causing the supporting clays to swell. The backfill, because of its loose condition, does not effectively oppose the the tightened joints. Such movement in corrosion-weakened pipe could well cause flexural or joint failure. The magnitude of the movement is particularly significant when it is realized that for the entire time that the test pipes were installed, generally wet climatic conditions prevailed. There were no dry soil conditions which would have permitted soil shrinking.

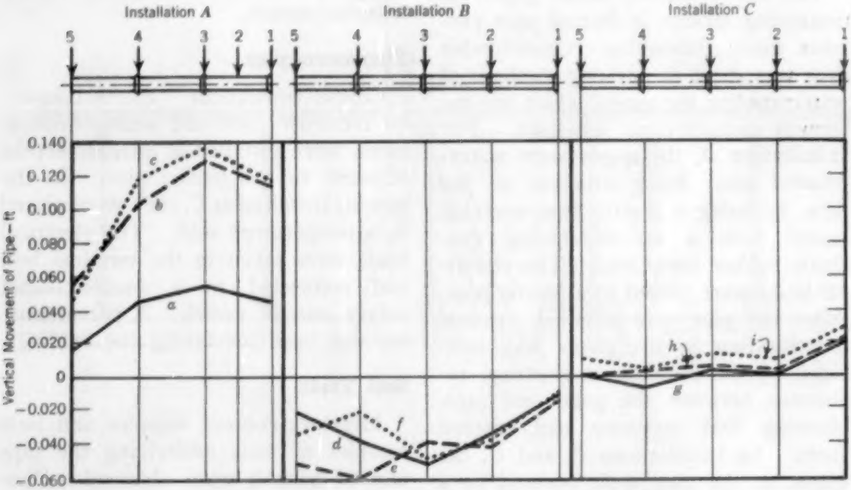

Fig. 3. Typical Vertical Movements in Test Installation Mains

Installation A, *installed Dec. 19, 1953, was of 6-in. cast-iron pipe. Installation* B, *installed Aug. 24, 1954, and Installation* C, *installed Nov. 18, 1954, were of 4-in. cast-iron pipe. Dates of the tests for which data are shown were as follows:* a—*Mar. 31, 1954;* b—*Oct. 20, 1954;* c—*Mar. 12, 1955;* d—*Sep. 1, 1954;* e—*Oct. 20, 1954;* f—*Mar. 12, 1955;* g—*Jan. 2, 1955;* h—*Feb. 14, 1955;* i—*Apr. 30, 1955. Datum is the elevation of pipe on date of installation.*

upward movement. Winnipeg uses this "trench and tunnel" method for laying pipe under paved streets or for winter work when excavation in frozen ground is extremely expensive.

More important, however, is the differential movement of the buried pipe exhibited by all three test installations. This amounted to as much as ¾ in. and sometimes caused ½ deg. of rotation at the tightened joints.

It was found that the electric strain gages could be successfully waterproofed. The readings showed that the pipe was subject to axial as well as flexural stresses, and that bending could take place both in a vertical and horizontal direction. Because considerable study is still required in successfully developing the electric strain gages for underground work, only

qualitative results can be given at this time. It is interesting to note that high strains developed in the pipe on backfilling and that these strains have remained high.

For Installation *A*, the thermocouple showed a maximum frost penetration of 8 ft during the winter of 1953–54. This unusually deep penetration was caused by the frozen condition of the backfill when it was placed in the trenches. During the winter of 1954–55, frost penetration reached a depth of 5 ft in mid-March. The coldest ground temperature reached, other than at the surface, was 20°F at a 1-ft depth. At 8 ft, the temperature varied between 35° and 45°F. For Installation *C*, it was found that, from the end of October to the beginning of March, the ground at pipe depth was approximately 1–3°F warmer than the pipe. The coldest water temperature reached was 34°F and the coldest ground temperature at this depth was 35°F. The test pipes have not been installed for a sufficient length of time to permit a comparison of summer ground and pipe temperatures. Based on readings made to date, however, it is possible that the water is at least 9°F warmer than the ground.

This report represents only a condensation of the results obtained.

Conclusions

It will be clear that this paper is essentially a report of progress made on a long-term, extensive research project, which is still under way. Detailed findings and conclusive results will be reported in due course in appropriate research papers. The results obtained to date, however, show that the investigation has implications that go far beyond the purely local problem. On the basis of what the project has already revealed, both from a study of the cumulative experience of the water works branch of Winnipeg's Eng. Dept. and from the initial information gained in the test installations, the following conclusions can be made:

1. Water main breaks occurring in the Winnipeg system have constituted a problem throughout the years that is of such magnitude that it has necessitated detailed analysis and regular review.

2. The corrosive character of the local soils in the presence of moisture is undoubtedly a principal factor in the failure of cast-iron mains. But other considerations, such as the breaks occurring in steam-cured asbestos-cement pipe, which has high corrosion resistance, and the seasonal recurrence of a peak in the number of failures, indicate that the physical environment of the pipe is also partly responsible for the failures. Cumulative experience with Winnipeg soils indicates that the associated factor is differential soil movement.

3. Such differential soil movements can result when pipe trenches are excavated in clay soils which are susceptible to swelling or shrinking with changes in the moisture content, a difficulty which is inevitably traced back to the backfilling operation.

4. The initial readings show that, because of differential soil movements, the pipes move to such an extent after installation that appreciable bending stresses may be induced. These stresses are believed to be of such magnitude that they could cause the failure of corrosion-weakened pipe.

5. The previously observed interaction of soil and pipes confirms most emphatically the long recognized importance of properly backfilling pipe trenches and of laying pipe on well

prepared soil beds without the use of solid blocking.

6. Even when excellent workmen are involved, field observations confirm the difficulty of achieving good laying practice without almost continual inspection of every pipe-laying operation.

7. Although the Winnipeg soil conditions are unusual, they are by no means unique. The experience recorded in this paper, then, is probably applicable to many other areas.

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Restoration of Pressure Equilibrium in Membrane Filtration

William J. Tarrant

A contribution to the Journal by William J. Tarrant, Chemist, Filtration Plant, Saginaw, Mich.

When filtration is done only occasionally, or simple glass, paper, or asbestos fiber filters are used, the difficulties of restoring atmospheric pressure to a filter flask seem rather insignificant. Because of the increased use of the membrane filter for coliform-bacteria differentiation and other specific purposes, however, these problems are assuming new importance.

Although the membrane filter disc readily removes the aqueous carrier of organisms by the pressure differential obtainable from an ordinary laboratory aspirator, or filter pump, the wet disc resists the passage of air needed to restore atmospheric pressure when the vacuum line has been closed. This condition is proportionate to the size of the flask being used and the diameter of the membrane. A material drying of the membrane is effected in the slow passage of air in pressure equalization, a circumstance which may make it more difficult to obtain a quick contact of nutrients to the entire surface of the membrane upon its transfer to enrichment media. Obviously, the two most simple means of relieving the vacuum in a filter flask are the removal of the vacuum connection or the lifting of the stopper holding the filter funnel. The former method may result in breaking the stem from the flask, while the latter surely endangers the flask, the funnel, and the operator; both interfere with other operators using the same aspirator. Turning off the aspirator is hardly a satisfactory solution to the problem because the "residual vacuum" in the flask forces some water from the aspirator through the connecting tubing into the filtrate, which could not then be used as a sterile rinse solution if desired. With very careful handling, a membrane can be removed from the funnel against a pressure differential, but the membrane is quite likely to be torn or contaminated.

There is a need for a safe and convenient technique for quickly restoring atmospheric pressure to the filter flask, in order to facilitate the running of numerous consecutive samples, to reflect a more scientific approach, and to provide a control to aid in staining membranes for direct microscopic examination.

Spring tubing clamps on both the vacuum line and the vent line provide the simplest good technique for vacuum relief. A two-way stopcock can take the place of the Y or T connector needed when spring clamps are used, and there is good indication that a filter flask may soon be manufactured

with a suitable stopcock which will obviate further "gadgeteering." A two-valve, bench type gas or air outlet will undoubtedly furnish the most economical solution to the problem as most laboratories have at least one such apparatus which is not used for its original purpose. The filter flask in this arrangement attaches to the pipe fitting (which may also be fitted with a hose nipple), while the aspirator is connected to one of the stopcocks, with the other stopcock serving as the vent to the atmosphere. The only disadvantage in using such a device is that there are two valves to operate, although they could be connected with a bell crank so that both cocks could be operated simultaneously.

Aircraft Pitot Valve

A very clever two-way valve used in various aircraft is suitable to the application under discussion and may be purchased at some war surplus stores. The valve, which very closely resembles an electric switch of the aircraft type, connects the airspeed indicator to the pitot tubes. This "static-pressure selector valve" has three openings, the center one of which may be connected with either of the other two by simply raising or lowering the valve toggle. Attaching the filter flask to the center opening and the vacuum line to one of the others leaves the third opening for the vent to the atmosphere. Flicking the switch from one position to the other relieves or restores vacuum to the flask. The valve, made of aircraft metals and measuring only $1\frac{3}{4} \times 2\frac{1}{2} \times 1\frac{1}{2}$ in., is light enough to attach to the neck of a filter flask that has a capacity of at least 1 liter. An aircraft hose clamp makes a very convenient device with which to attach the valve to the flask, and the glass can be protected against breakage by placing a strip of soft rubber under the hose clamp to prevent any metal to glass contact. If a slow vacuum relief is desired, an orifice can be made by turning a $\frac{1}{8}$-in. brass pipe plug into the atmosphere vent, which is already threaded. An orifice hole of suitable size must be drilled through the plug. Usually, a rapid relief of vacuum is de-

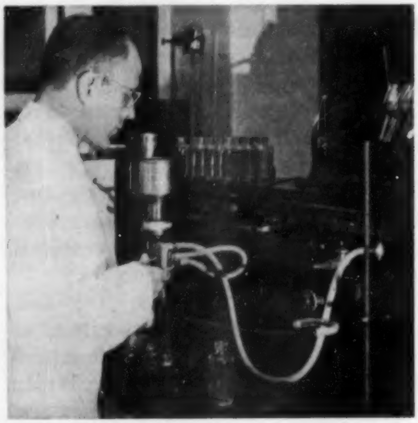

Fig. 1. Pitot Valve Attached to Filter Flask

The center opening of the valve is attached to the filter flask. Vacuum can be relieved or restored in the flask by flick- the toggle switch, which changes the connection from atmosphere to vacuum line.

sirable, however, because the momentum of air rushing into a filter flask at the stem tends to loosen the membrane from the carbon or fritted-glass support disc of the funnel. The aircraft pitot valve provides a satisfactory connection, even where several operators are using the same vacuum pump, because the vacuum line to the filter pump is occluded when a flask is vented to the atmosphere.

The pitot valve can be mounted in a box or attached to a bracket a short distance from the flask, of course, but usually these arrangements are not as convenient as having the valve placed on the flask. The pitot valve, seldom priced more than $1 in most surplus stores, should make an economical unit. Suitable vacuum control is especially important for certain techniques, such as staining a membrane for direct microscopic examination, in which it is necessary to keep staining solutions on the membrane for a definite length of time. The few minutes spent in preparing any of the suggested relief devices will reward the operator with greater ease of work.

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Census of Fluoridation in the United States and Canada, 1954

Task Group Report

A report of Task Group 2620 P—Fluoridation Materials and Methods, presented on Jun. 16, 1955, at the Annual Conference, Chicago, Ill., by J. C. Zufelt (then Chairman), Supt., Board of Water Comrs., Sheboygan, Wis. Other members of the committee were R. L. Derby, H. A. Faber, A. E. Griffin, L. E. Harper, F. J. Maier, O. J. Muegge, R. W. Ockershausen, R. S Phillips (now Chairman), L A. Smith, F. S. Taylor, H. W. Tracy, and D. B. Williams.

THE committee undertook three projects during the past year. The first of these was to bring the 1953 census of fluoridation installations up to date as of Dec. 31, 1954. The results of this project are shown in Table 1, which supplements the 1953 census published in the September 1954 JOURNAL (*1*). A summary of the fluoridation census for the years 1945–54 is shown in Table 2. In 1954, 187 additional installations were put into operation. Eight communities—San Diego, Calif.; St. Martinsville, La.; Hudson, Mass.; Saginaw, Mich.; Tecumseh, Mich.; Akron, Ohio; Wichita Falls, Tex.; and LaCrosse, Wis.—discontinued fluoridation during the year. Thus, the net increase in fluoride installations during 1954 was 179. Table 3 shows the status of court actions in several communities.

The second project was to determine the requirements of the various state, territorial, and provincial health departments as to testing and sampling procedures in water utilities which practice fluoridation. O. J. Muegge, Wisconsin State San. Engr., undertook this project and carried it out with the assistance of Ceaser Stravinski and others of his staff. Their report is included in this paper.

The third project will be to determine the relative accuracy of permanent color standard fluoride test kits. F. J. Maier, of the US Public Health Service, has worked out a program involving six water plant laboratories for testing the accuracy of the kits under different conditions of departure from specified temperature, time of reaction, and age of reagents. Test results will be compared with *Standard Methods* procedure (*2*). This work is expected to begin soon.

Fluoride Test Procedures

The committee forwarded a questionnaire to the state, territory and Canadian provincial health departments to obtain information on the present requirements of these governmental units concerning laboratory controls, sampling procedures, and testing methods. It requested their comments on the accuracy of the Hellige * and Taylor † test kits. For purposes of simplification in reporting the results, the states, territories, and Canadian provinces have all been classified as states.

Of the 60 questionnaires forwarded, 52 were returned. Four states indi-

* Hellige, Inc., Long Island City, N.Y.
† W. A. Taylor & Co., Baltimore.

TABLE 1

*Census of Fluoridation in the United States and Canada, Dec. 31, 1954 **

Location Served	Population Served	Chemical Used			Natural F *ppm*	F Residual Maintained *ppm*	Date Installed
		NaF	Na_2SiF_6	H_2SiF_6			
Arkansas							
Harrison	5,542						5/54
Helena	11,236						9/54
Marianna	4,530						11/54
Newport	6,254						7/54
West Helena	6,107						10/54
California							
Fresno W.D.	100	S				0.9	9/54
Gridley	3,054						5/54
Martinez	8,268						6/54
Pleasanton	2,444						3/54
San Luis Obispo	16,000		D		0.0	1.0	7/54
St. Helena							
Vallejo (+1)	80,000		D		0.0	1.0	11/54
Colorado							
Denver (+7)	527,000					1.0	5/54
Gunnison	2,739						3/54
Loveland	6,773						6/54
Florida							
Naples	1,465						8/54
Georgia							
Cobb County (+4)	79,653						8/54
Fort Valley	6,820						3/54
Griffin (+3)	24,688						
Thomasville	14,424						11/54
Valdosta	20,000						12/54
Idaho							
Council	748						1/54
Meridian	1,810						12/54
Orofino	1,656						3/54
Richfield	429						7/54
Illinois							
Gurnee	1,097				0.1	1.2	8/54
Harvey (+6)	33,917		D		0.1	1.2	4/54
Morton Grove	1,820		D		0.1	1.0	2/54
Newton	2,280	S			0.2	1.2	4/54
Quincy†	41,450				0.1	1.2	4/54
Sesser (+1)	2,896		D		0.2	1.2	11/54
Sparta	3,576		D		0.2	1.2	4/54
York Center	256	S			0.3	1.2	4/54

* Supplements 1953 census (*1*). Key to symbols and abbreviations in table: W.D.—water district; D—dry-feed equipment; S—solution- or slurry-feed equipment (slurry feed is applicable only to sodium silicofluoride installations); St—saturator type feeder. A number in parenthesis following the name of a city indicates the number of other communities served by it.

† Uses ammonium silicofluoride with dry feeder.

TABLE 1 (*contd.*)—*Fluoridation Census, 1954**

Location Served	Population Served	Chemical Used			Natural F *ppm*	F Residual Maintained *ppm*	Date Installed
		NaF	Na_2SiF_6	H_2SiF_6			
Indiana							
Jasonville (+2)	4,556		D		0.0	1.0	4/54
La Porte	20,414		D		0.0	1.0	9/54
Long Beach	1,103						
Michigan City	28,379						2/52
New Castle	18,271		S		0.2	1.0	8/54
Potowatami							
Seymour	9,629		D		0.2	1.0	2/54
Kansas							
Arkansas City	14,302						6/53
Coffeyville (+1)	7,114						10/52
Colony	400						12/52
El Dorado	11,878						10/52
Fort Scott	10,447						8/52
Fredonia	3,257						11/54
Minneapolis	1,801						7/54
Osawatomie	4,347						8/54
Kentucky							
Calhoun	753						1/54
Cumberland	4,250						12/54
Danville	8,686						5/54
Lexington	55,534						4/54
Louisiana							
Lockport	1,500						8/54
Maine							
Bangor	31,558		S		0.0	1.0	1/55
Maryland							
Annapolis	10,047						8/54
Frederick	19,000						2/54
Massachusetts							
Essex	1,795	St.					12/54
Scituate	5,993	S				1.0	
Topsfield	1,412						12/53
Michigan							
Gladstone	4,831						1/54
Grandville	2,022		D		0.15	1.0	1/54
Hillsdale	7,297						1/54
Petoskey	6,468						
Mississippi							
Calhoun City	1,319	D				1.0	11/54
Newton	2,912		D				9/54

* Supplements 1953 census (*1*). Key to symbols and abbreviations in table: W.D.—water district; D—dry-feed equipment; S—solution- or slurry-feed equipment (slurry feed is applicable only to sodium silicofluoride installations); St—saturator type feeder. A number in parenthesis following the name of a city indicates the number of other communities served by it.

† Uses ammonium silicofluoride with solution feeder.

TABLE 1 (*contd.*)—*Fluoridation Census, 1954**

Location Served	Population Served	Chemical Used			Natural F *ppm*	F Residual Maintained *ppm*	Date Installed
		NaF	Na_2SiF_6	H_2SiF_6			
Missouri							
Richland (+1)	1,430	S			0.2	1.0	5/54
Montana							
Bozeman	11,352						7/53
Fort Belknap	200						4/53
New Jersey							
E. Brunswick Twp.	11,700		D				12/54
Perth Amboy (+5)	66,300				0.2	1.0	6/54
New York							
Cobbleskill	2,617						10/53
Dresden	400						4/53
Levittown	15,041				0.0	1.0–1.2	1/54
Plattsburg	17,726						10/53
Riverhead	4,800	D				1.0	3/54
Walden†	4,559						4/54
Ohio							
Mineral Ridge	975	S				1.0	8/54
Oberlin	7,062						3/54
Wellston	6,994						7/54
Oklahoma							
Oklahoma City	250,000						6/54
Tonkawa	3,643		D		0.1	1.0	
Oregon							
Coquille	3,696						6/54
Mills City	1,792						3/54
Pennsylvania							
Clarion	5,200		D			1.2	7/54
Mansfield	2,657	D				1.2	2/54
Millersburg	2,900	D					10/54
Philadelphia	2,100,000			S		1.0	9/54
State College	17,227						6/54
Uniontown	26,800						7/53
South Carolina							
Cayce	3,294	D				1.0	11/54
Greenville (+9)	150,000						1/54
South Dakota							
Mitchell	12,123						11/54

* Supplements 1953 census (*1*). Key to symbols and abbreviations in table: W.D.—water district; D—dry-feed equipment; S—solution- or slurry-feed equipment (slurry feed is applicable only to sodium silicofluoride installations); St—saturator type feeder. A number in parenthesis following the name of a city indicates the number of other communities served by it.

TABLE 1 (*contd.*)—*Fluoridation Census, 1954* *

Location Served	Population Served	Chemical Used			Natural F *ppm*	F Residual Maintained *ppm*	Date Installed
		NaF	Na_2SiF_6	H_2SiF_6			
Tennessee							
Baxter	861					1.0	6/54
Lewisburg	5,156					1.0	7/54
Murfreesboro	13,027					1.0	5/54
Springfield	6,541					1.0	7/54
Woodberry	991					1.0	6/54
Virginia							
Alexandria (+6)	136,000						1/54
Newport News (+5)	150,000						4/54
West Virginia							
Belle	900						8/54
Bluefield	21,506						8/54
Bridgeport	2,414						3/54
Charleston (+1)	104,087						4/54
Clarksburg (+3)	37,753						1/54
Hinton	7,000						5/54
Martinsburg	15,621						2/54
Nitro	3,314						8/54
Pineville	1,082						3/54
Princeton	8,279						11/54
St. Albans	12,000						11/54
Welch	8,000						5/54
Wisconsin							
Pewaukee	1,784						3/54
Port Edwards	1,400	S			0.3	1.2	7/54
Weyauwega	1,207	S			0.1	1.0	1/54
Wyoming							
Thermopolis	2,870						2/54
CANADA ‡							
Ontario							
Brantford (+1)	50,000	S			0.2	1.0	6/45
Deep River (+1)	3,000		D		0.2	1.0–1.1	12/52
Fort Erie	9,000	S			0.1	1.0	1/52
Oshawa	45,000		D		0.1	1.2	2/53
Sudbury	65,000		D		0.1	0.9	8/52
Thorold (+1)	8,000	S			0.1	1.0	2/52
Saskatchewan							
Assiniboia	1,585	S			0.05–0.15	0.8	4/53
Moosejaw	23,069	D			0.2	1.0	11/52
Swift Current	6,379		D		0.1	1.0	10/54

* Supplements 1953 census (*1*). Key to symbols and abbreviations in table: W.D.—water district; D—dry-feed equipment; S—solution- or slurry-feed equipment (slurry feed is applicable only to sodium silicofluoride installations); St—saturator type feeder. A number in parenthesis following the name of a city indicates the number of other communities served by it.

‡ For some Canadian cities, the figures in this table represent changes in or additional information on the installations as reported in the 1953 census (*1*).

TABLE 2
Summary of Fluoridation Plant Census, 1945–54

United States					Canada	
Year	States With Plants	No. of Water Systems	Communities Served	Total Population Served	No. of Water Systems	Total Population Served
1945	3	3	3	209,000	1	40,000
1946	7	9	9	302,000	1	40,000
1947	9	11	11	388,000	1	40,000
1948	9	13	18	493,000	1	40,000
1949	11	27	33	777,000	1	40,000
1950	16	62	78	1,384,000	1	50,000
1951	37	172	240	4,410,000	1	50,000
1952	43*	354	447	12,590,000	5	128,000
1953	43*	480	842	15,900,000	8	192,000
1954	44*	574	1,021	20,369,464	9	198,000

* Plus District of Columbia.

cated they did not have fluoridation installations, and two indicated that their replies referred to proposed controls for future fluoridation programs. A summary of the information in the 48 completed questionnaires follows:

All states except one required that check samples be submitted to a state laboratory or an approved laboratory, or that samples be obtained by departmental personnel. Most states indicated that one monthly sample is required, with several states indicating that the number to be submitted would vary with the size of community. Some states required more frequent testing during the initial period of operation.

Forty-four states required fluoride determinations to be made by local water departments. Of these, 41 indicated daily testing, 2 indicated weekly testing, and one indicated that the requirement would depend on the size of the community. Four states did not require fluoride determinations at all. The number of daily samples to be collected varied from one to three in the majority of cases. The highest number of daily samples was eight, required by only one state.

Table 4 shows the methods used by the state laboratories in making fluoride tests. The Scott-Sanchis zirconium-alizarin color reaction method, specified in *Standard Methods* (2) is the favored procedure, and 37 of the 46 laboratories use it either alone or in conjunction with other methods. Only two laboratories rely exclusively upon tests using permanent glass color standards.

Of the 520 communities for which information was available, 74 make fluoride determinations using *Standard Methods* procedure, 15 use the Rubin modification, 310 Hellige, 120 Taylor, and one the La Motte * kit.

Thirty-four states indicate that the individual making the fluoride determination at the local water department needs to have special training or be approved or certified. Thirteen did not require special qualifications and one indicated that the item was not covered in their proposed procedures.

Collection of composite samples was a requirement for two states. It was

* La Motte Chem. Co., Inc., Baltimore.

suggested procedure in 14 others, and 32 states indicated no preference.

Samples for fluoride determinations by local water departments are collected from plant taps and the distribution system in 33 states, from plant taps only in 6 states, and from distribution systems only in 9 states.

Thirty-five states feel that daily calculations of the theoretical fluoride ion concentration do not by themselves provide sufficient control to obviate making residual fluoride determinations. Ten states believe the daily calculations alone are satisfactory, although three of these states feel residual fluoride determinations are necessary for surface supplies, for waters with varying fluoride concentrations, and at all installations without capable operators. Three states did not answer this question.

Thirty-eight states required the submission of reports indicating pumpage, pounds of chemical used, theoretical fluoride ion concentration, and results of fluoride determinations. Of these 38 states, 32 required monthly reports and 6 required weekly reports. Ten states had no requirements regarding the submission of these reports.

TABLE 3

Court Actions on Fluoridation

Court Action Favorable—Fluoridation in Progress	
Baltimore, Md. Fargo, N.D.* Greenville, S.C. La Porte, Ind.	Milwaukee, Wis.* New Castle, Pa. Philadelphia, Pa. Tulsa, Okla.*†
Court Action Favorable—Fluoridation Not in Progress	
Bend, Ore. Chehalis, Wash.*	Cleveland, Ohio* Shreveport, La.*†
Court Action Favorable—Fluoridation Voted Out	
Northampton, Mass.	San Diego, Calif.*†

* Case was considered by state supreme court and a decision favorable to fluoridation was rendered.
† Case went to US Supreme Court, which refused to review it.

TABLE 4

Fluoride Testing in State Laboratories

Method or Equipment Used	No. of States
Scott-Sanchis only	25
Scott-Sanchis and Hellige	7
Scott-Sanchis, Hellige, and Taylor	1
Scott-Sanchis, Hellige, and Rubin	1
Scott-Sanchis, Hellige, and Megregian-Maier	1
Scott-Sanchis and Megregian-Maier	1
Scott-Sanchis and Rubin	1
Megregian-Maier modification only	4
Megregian-Maier and Lamar modifications	1
Lamar modification only	4
Hellige only	2

Seventeen states furnished information concerning their tests or experiences as to the accuracy of the Hellige and Taylor test sets. The replies indicate considerable differences in test results and experiences. Several states consider the Hellige more satisfactory than the Taylor units. One state reports higher results with Hellige than with standard methods, while another reports lower results. Several states indicate that results obtained from either set will vary because of variations in strength of reagents, one state reporting deviations up to 0.7 ppm. Another state reports both kits are subject to temperature variations and give results as much as 0.5 ppm higher than actual concentration in hot weather.

References

1. Committee Report. Census of Fluoridation in the United States and Canada, 1953. *Jour. AWWA,* **46**:920 (Sep. 1954).
2. *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes.* APHA, AWWA & FSIWA, New York (10th ed., 1955). p. 98.

AWWA Safety Manual

Part 4—Bibliography of Safety Information Sources

Parts 1–3 of the AWWA Manual on Safety Practice for Water Utilities, prepared by the AWWA Committee on Safety Practices, have appeared in previous issues (July–November 1955). The bibliography below is the concluding installment. The entire manual, with an introduction and index, will be available as a separate volume, probably in March 1956. Publication date and price information will be given in a future issue of the Journal.

It is too much to hope that this manual will answer every question on safety. The subject is too large and too changing to attain such a goal. As the next best thing to having an answer to a problem is to know where to find the answer, a short bibliography of pertinent safety information sources follows. For many utilities, it may be advisable to have a copy of several of the documents listed here available for ready reference.

Construction Safety

Manual of Accident Prevention in Construction. Associated General Contractors of America, 1227 Munsey Building, Washington 4, D.C. Price, $3.

Industrial Safety

Accident Prevention Manual for Industrial Operations. National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill. Price, $13.50.

First Aid

American Red Cross First-Aid Text Book. American Red Cross, 315 Lexington Ave., New York 36, N.Y. Price, 60¢.

Fire Codes

Vol. I—Flammable Liquids and Gases. Price, $6; *Vol. II—Combustible Solids, Dusts, Chemicals, and Explosives.* Price, $6; *Vol. III—Building Construction and Equipment.* Price $6; *Vol. IV—Extinguishing Equipment.* Price, $6; *Vol. V—Electrical.* Price, $6; *Vol. VI—Transportation.* Price, $6; *NFPA Handbook of Fire Protection.* Price, $10.50. National Fire Protection Assn., 60 Batterymarch St., Boston 10, Mass.

Chlorine Handling

Chlorine Manual. Chlorine Institute, 50 E. 41st St., New York 17, N.Y. Free on request.

Injuries

Work Injuries in the United States. US Dept. of Labor, Supt. of Documents, US Government Printing Office, Washington, D.C. Price, 30¢.

Safety Standards

The following publications are available from American Standards Assn., 70 E. 45th St., New York 17, N.Y. The free ASA bulletin 5501 provides a price list of all available ASA standards.

Industrial Lighting—ASA A11.1. Price, 50¢.

Safety Code for Floor and Wall Openings, Railings and Toe Boards—ASA A12. Price, 50¢.

Safety Code for Portable Wood Ladders—ASA A14.1. Price, 75¢.

Safety Code for Elevators, Dumbwaiters, and Escalators—ASA A17.1. Price, $1.50.

Safety Code for the Use, Care and Protection of Abrasive Wheels—ASA B7.1. Price, 75¢.

Safety Code for Mechanical Power Transmission Apparatus—ASA B15.1. Price, $1.

Safety Code for Compressed Air Machinery and Equipment—ASA B19. Price, 50¢.

Safety Code for Conveyors, Cableways and Related Equipment—ASA B.20.1. Price, 90¢.

Safety Code for Cranes, Derricks, and Hoists—ASA B30.2. Price, $1.80.

Safety Code for Industrial Power Trucks—ASA B56.1. Price, 85¢.

Safety Code for Identification of Gas Mask Canisters—ASA K13.1. Price, 35¢.

American Standard Minimum Requirements for Sanitation in Places of Employment—ASA Z4.1. Price, 50¢.

Method of Recording and Measuring Work Injury Experience—ASA Z16.1. Price, 50¢.

Specifications for Industrial Accident Prevention Signs—ASA Z35.1. Price, 75¢.

Men's Safety Shoes—ASA Z41.1. Price, 75¢.

Safety in Electric and Gas Welding and Cutting Operations—ASA Z49.1. Price, 50¢.

There are many organizations, beyond those listed above, which supply information on safety. In the following partial list, no attempt has been made to record the titles of material that may be secured from such groups. The broad subjects with which they are concerned are, however, indicated.

1. *Toxicology engineering:* Industrial Hygiene Foundation, 4400 Fifth Ave., Pittsburgh 13, Pa.
2. *Approved industrial fire protective equipment:* Associated Factory Mutual Fire Insurance Companies, Factory Mutual Eng. Div., 184 High St., Boston 10, Mass.
3. *Standards and recommended practices in relation to fire prevention:* National Board of Fire Underwriters, 85 John St., New York 7, N.Y.
4. *Materials testing:* Underwriters' Laboratories, 207 E. Ohio St., Chicago 7, Ill.
5. *Radiation protection:* Atomic Energy Commission, 19th St. & Constitution Ave., N.W., Washington, D.C.
6. *Safety equipment specifications:* General Services Administration, Federal Supply Service, Technical Committee on Safety Equipment, Washington, D.C.
7. *Underground safety:* Dept. of the Interior, Bureau of Mines, Washington, D.C.
8. *Industrial safety:* Dept. of Labor, Washington 25, D.C.
9. *Public and industrial safety:* Association of Casualty and Surety Companies, Accident Prevention Dept., 60 John St., New York 7, N.Y.
10. *Accident and fire prevention:* American Mutual Alliance, Accident and Fire Prevention Div., 919 N. Michigan Ave., Chicago 11, Ill.
11. *Gas:* American Gas Assn., 420 Lexington Ave., New York 17, N.Y.
12. *Oil and gasoline:* American Petroleum Institute, Dept. of Safety, 50 W. 50th St., New York, N.Y.
13. *Welding:* American Welding Society, 33 W. 39th St., New York 18, N.Y.
14. *Electrical safety:* Edison Electric Institute, 420 Lexington Ave., New York 17, N.Y.
15. *Lighting:* Illuminating Eng. Society, 51 Madison Ave., New York 10, N.Y.
16. *Explosives:* Institute of Makers of Explosives, 343 Lexington Ave., New York 16, N.Y.
17. *Boilers:* National Board of Boiler and Pressure Vessel Inspectors, Brunson Building, 145 N. High St., Columbus 15, Ohio.

Finally, there are two services provided by every state and provincial government which are important to any safety program:

1. Enforcement of accident prevention regulations and the payment of compensation claims by labor offices
2. Industrial-hygiene services—usually associated with the state or provincial department of health; such government offices are equipped to investigate health hazards relating to dust, ventilation, fumes, vapors, and other respiratory dangers and to make recommendations on their elimination.

Make use of these services if the occasion demands expert advice.

1955 Conference—Chicago

A RECORD registration—more than 25 per cent above the previous high—was the key to the unprecedented success of every function and feature of AWWA's 75th annual conference, held last Jun. 12–17 in the Conrad Hilton Hotel, Chicago. With more men on hand than there had ever been total attendants before, technical sessions, exhibits, inspection trips, and all other official meetings and activities were playing to capacity audiences all week. And with all but a new record in ladies' attendance as well, the feminine end of the program, too, was sold out throughout. Had the hotel been anything but the world's largest, it wouldn't have been large enough to contain this world's largest water works meeting. And if the host section had been anything less than the world's most enthusiastic, it wouldn't have been prepared to entertain a guest list that exceeded all expectations.

Chief Enthusiastician was Ed Alt, chairman of the Convention Management Committee, whose job it was to supervise everything. On the committee with Ed were:

Representing AWWA	*Representing WSWMA*
C. C. Abplanalp	T. T. Quigley
D. W. Johnson	L. F. Frazza

Ex Officio

Dale L. Maffitt, *President*	Harvey S. Howe, *President*
Harry E. Jordan, *Secretary*	John G. Stewart, *Manager*
Richard Hazen, *Chm., Publication Com.*	

To accommodate full coverage of the growing variety of water works interests, Dick Hazen's Publication Committee worked out a full program of sixteen regular technical sessions that presented the work of 100 different speakers. These addresses, together with the many reports presented at the business meetings of the four divisions, poured into the Journal files more material than could be published in the last half of the year. The formal papers presented are listed on pages 1226–28; those that have not already been published will appear in the 1956 Journal.

John Stewart's Exhibit Committee, too, had to accommodate a record demand for space, and the 167 boothsful of exhibits represented a new high not only in space and exhibitors, but in equipment and interest as well. And with the exhibits right downstairs, more people found it possible to do a little looking more often.

Looking to the entertainment were a host of hosts including Jim Jardine, Scranton Gillette, Tom Storms, Hy Gerstein, Mike Foley, Clarence Klassen,

1955 CONFERENCE STATISTICS

Chicago Registration by Days

Day	Men	Ladies	Total
Sunday, Jun. 12	1,085	309	1,394
Monday, Jun. 13	674	162	836
Tuesday, Jun. 14	170	35	205
Wednesday, Jun. 15	100	6	106
Thursday, Jun. 16	46	–	46
TOTALS	2,075	512	2,587

Geographic Distribution of Registrants

UNITED STATES & TERRITORIES

Alabama	42
Arizona	12
Arkansas	17
California	98
Canal Zone	1
Colorado	23
Connecticut	23
Delaware	3
Dist. Columbia	11
Florida	34
Georgia	42
Hawaii	1
Illinois	492
Indiana	110
Iowa	91
Kansas	41
Kentucky	31
Louisiana	26
Maine	7
Maryland	27
Massachusetts	30
Michigan	133
Minnesota	42
Mississippi	9
Missouri	100
Montana	8
Nebraska	18
New Hampshire	2
New Jersey	118
New Mexico	5
New York	214
North Carolina	34
North Dakota	5
Ohio	161
Oklahoma	13
Oregon	7
Pennsylvania	180
Puerto Rico	4
Rhode Island	16
South Carolina	15
South Dakota	8
Tennessee	37
Texas	64
Utah	5
Vermont	2
Virginia	28
Washington	16
West Virginia	20
Wisconsin	100
Wyoming	1

CANADA

Manitoba	4
Nova Scotia	1
Ontario	39
Quebec	5
Saskatchewan	1

FOREIGN

Africa	3
Asia	3
South America	4
TOTAL	2,587

Comparative Registration Totals—1946–1955

Year	Place	Men	Ladies	Total
1955	Chicago	2,075	512	2,587
1954	Seattle	1,536	527	2,063
1953	Grand Rapids	1.532	365	1,897
1952	Kansas City	1,600	386	1,986
1951	Miami	1,415	491	1,906
1950	Philadelphia	1,678	329	2,007
1949	Chicago	1,593	374	1,967
1948	Atlantic City	1,348	356	1,704
1947	San Francisco	1,115	431	1,546
1946	St. Louis	1,303	214	1,517

Win, Place & Show in Section Awards

Henshaw Cup		Hill Cup		Old Oaken Bucket	
Alabama-Mississippi	**66.1%**	**Pacific Northwest**	**45.65**	**California**	**1,193**
Ohio	62.7%	California	29.38	Southwest	945
Montana	61.8%	Southeastern	24.24	New York	805

and the Missuses Cy Bird, John Barksdale, Ed Alt, and Harry Schlenz. And the program that they looked to looked good to everyone. Beginning with a buffet as a Sunday evening meet and greet affair, every minute away from work had something doing. Monday night saw the distribution of honors to the year's awardees, followed by a reception and dance; Tuesday turned back the clock to the nights of Diamond Jim, for gambling and dancing and costumery; and Wednesday changed pace again to a relaxing movie. Finally, Thursday's annual banquet and ball brought out 1,100 to welcome Frank Amsbary into presidency. The ladies, too, were busy all week long, bouncing from tea to fashion show to luncheon and back again, as well as keeping up with the general entertainment program.

Moving the multitude this year was new Transportation Committee Chairman Lou Frazza—new only as chairman, though, for Lou had labored long as a member of the committee. To take over when the masses arrived, there were Roy Beckman and Warren Wolfe, with their Local Host Committee. And in one way or another just about everyone in the Illinois Section and its neighboring states got into the act to share the credit for this even bigger than biggest!

Association Awards

Honorary Membership was conferred upon Louis E. Ayres, of Ann Arbor, Mich.; Linn H. Enslow, of New York, N.Y.; and Herbert B. Foote, of Helena, Mont. The citations follow:

Louis Evans Ayres, Consulting Engineer, Partner, Ayres, Lewis, Norris & May, Ann Arbor, Mich.: *a loyal and active member of the Association since 1916; a devoted worker within the Michigan Section; Director 1953–56; received the Fuller Award in 1950; a consulting engineer of highest standing; the industrious leader of the Committee on Water Rates, stimulating his associates toward production of a valuable report which will serve as a guide to the water works industry for many years.*

Linn Harrison Enslow, Editor, *Water & Sewage Works: member of the Association since 1918; President 1948–49; recipient of the Diven Medal in 1935; served as a member of the Special Committee on AWWA Policy on Fluoridation of Public Water Supplies which received the Goodell Prize in 1949; received the Fuller Award for the New York Section in 1951; served as Chairman of the Association's Publication Committee 1936–47; gifted with an inquiring mind and the will to search for truth; responsible for many contributions to the advancement of chlorination, thus sharing the credit for the great gift to humanity derived from this forward step in sanitation.*

Herbert Branch Foote, Retired Director, Division of Environmental Sanitation, State Board of Health of Montana: *member of the Association since 1923; Director for the Montana Section, 1931–33; received the Fuller Award in 1942; while serving the people of Montana for many years as their state sanitary*

engineer, he was also responsible for the organization and growth of the Montana Section; respected and beloved by all those who have worked with him.

The John M. Diven Medal, awarded to the member whose services to the water works field during the preceding year are deemed most outstanding, was presented to A. P. Black. The citation follows:

ALVIN PERCY BLACK, Head of the Department of Chemistry, University of Florida: *for his constructive leadership in the establishment and maintenance of a sound policy for the water works industry concerning the fluoridation of public water supplies, together with his many important contributions to the Association and the advancement of water works practices.*

The John M. Goodell Prize, granted for the best paper published in the JOURNAL from October 1953 through September 1954, was conferred upon Paul D. Haney. The citation follows:

PAUL DUNLAP HANEY, Consulting Engineer, Black & Veatch, Kansas City, Mo.: *for his paper entitled "Theoretical Principles of Aeration," published in the April 1954 issue of the Journal* (Vol. 46, page 353). *This paper is a thorough and scholarly statement of the factors involved in the aeration of water and should prove to be a valuable reference source for many years to come.*

Division Awards, granted for the best JOURNAL paper (October 1953–September 1954) in the field of interest of each of the four AWWA Divisions, were presented to Erwin O. Potthoff, John H. Murdoch Jr., Paul D. Haney, and Herbert E. Hudson Jr. The citations follow:

Distribution Division Award: ERWIN O. POTTHOFF, Application Engineer, Industrial Engineering Section, General Electric Co., Schenectady, N.Y.: *for his paper entitled "Motor Drives for Water Pumps." This paper, coauthored by M. C. Boggis (nonmember) and published in the October 1953 issue of the Journal* (Vol. 45, page 1023), *is particularly valuable as a practical guide to the selection of proper motors for water works pumping applications.*

Management Division Award: JOHN HUEY MURDOCH JR., Vice-President, American Water Works Co., Wilmington, Del.: *for the paper entitled "There Is Work to Be Done." This paper, published in the April 1954 issue of the Journal* (Vol. 46, page 311), *points out the challenge that the water works field offers to young men choosing it as a career and offers inspiration toward progress for those already engaged in it.*

Purification Division Award: PAUL DUNLAP HANEY, Consulting Engineer, Black & Veatch, Kansas City, Mo.: *for the report entitled "Characteristics and Effects of Synthetic Detergents." This task group report, which was published in the August 1954 issue of the Journal* (Vol. 46, page 751), *most fully promotes the basic objectives of the Water Purification Division by stimulating research in the physical, chemical bacteriological, and biological examination of water as*

related to the causes and effects of pollution and to methods of treatment. Its value to the technology and literature of the field and its quality of presentation are outstanding. The members who served on the Task Group (Effects of Synthetic Detergents on Water Supplies) under the leadership of Mr. Haney are: R. L. Culp, J. D. Enright, W. D. Hatfield, H. E. Lordley, and J. C. Vaughn.

Resources Division Award: HERBERT EDSON HUDSON JR., Head of the Engineering Subdivision, Illinois State Water Survey: *for the report entitled "Water Conservation in Industry." This task group report, which was published in the December 1953 issue of the Journal* (Vol. 45, page 1249), *not only outlines the various means by which industry is already cooperating in conserving the water resources of the nation, but calls attention to the need for the cooperative atitude of water works men in working with local industry on conservation problems. The members who served on the Task Group (Industrial Water Use) under the leadership of Mr. Hudson are: S. W. Bergen, C. H. Capen, R. W. Davenport, L. L. Hedgepeth, H. R. Hooper, H. L. McMullin, W. J. O'Connell, S. T. Powell, M. J. Sassani, L. F. Warrick, and C. V. Youngquist.*

The Harry E. Jordan Scholarship Award, granted to further the education of a deserving applicant from the Midwest (a different region is selected each year), was conferred upon PAUL ANTON KUHN, a 1954 sanitary engineering graduate of the University of Illinois.

The George Warren Fuller Awards were presented to 25 men whose Sections had nominated them in the year beginning with the 1954 Annual Conference at Seattle and ending with the opening of the 1955 Conference at Chicago. The awards—which are conferred for "distinguished service in the water supply field and in commemoration of the sound engineering skill, the brilliant diplomatic talent, and the constructive leadership of men in the Association which characterized the life of George Warren Fuller"—went to the following men:

Alabama-Mississippi Section—TIP HENRY ALLEN: for his long and untiring devotion to, and advancement of, the water supply service of Canton, Miss.; and for his leadership efforts and interest in improvement of water works facilities in Alabama and Mississippi.

Arizona Section—PHILIP JOSEPH MARTIN JR.: for his intelligent management of the water supply of the city of Tucson; for his untiring efforts and his meritorious and inspirational services on behalf of the Section, particularly during its organization; and for his continuing loyalty to and services for the advancement of the Section.

California Section—MORRIS SHELLEY JONES: for his engineerineg ability and sound leadership; for his integrity, genuine modesty, and gentle friendliness; for more than 30 years of devotion to the advancement of AWWA and more than 40 years of faithful service to his community.

Canadian Section—FRANK YOUNG DORRANCE: for a lengthy period of public service with the city of Montreal, characterized by marked ability, high efficiency, and unselfish devotion to the interests of citizens in providing a fitting water works service.

Chesapeake Section—GEORGE LAIRD HALL: for his foresight and tireless efforts in initiating and successfully promoting legislation and financing methods which have resulted in improved public health conditions in the state of Maryland through adequate water supplies; and for his inspirational training of younger sanitary engineers.

Florida Section—DAVID BRYON LEE: for his exemplary efforts in behalf of general sanitation and water supply throughout the state; for his cooperation and that of his staff in the training of operators through short-course schools; and for his untiring interest in the Section, especially while serving as its national director.

Illinois Section—HYMAN H. GERSTEIN: for his inspiration and leadership in the Purification Division; for his devoted work in the Illinois Section, which has promoted sound practices in the operation and purification field; and for his contributions to the water works industry in general.

Indiana Section—CHARLES HAROLD BECHERT: In recognition of his 25 years of outstanding engineering service to the Department of Conservation in developing and conserving the water resources of Indiana; and for his valuable contributions to the Indiana Section.

Iowa Section—JOHN JOSEPH HAIL: in recognition of his superior management of the Dubuque Water Department; his unselfish and highly competent services to the Section; and his advancement of the interests of the Section and and the Association at all times during his many years of membership.

Kansas Section—ROBERT JOHNSON MOUNSEY: for his leadership in developing the certification program for Kansas water works operators; for his contribution to all activities of the Section; and for his constant devotion to the service of his community.

Michigan Section—EDWARD DANIEL BARRETT: in recognition of his leadership qualities as a member, officer, and past-chairman of the Michigan Section, culminating in his outstanding achievement as general chairman of the Annual Conference of the Association held at Grand Rapids in 1953.

Missouri Section—WILLIAM BLANCHARD SCHWORM: in recognition of his professional abilities and his noteworthy contributions to the fields of coagulation and disinfection; for his able participation as organizer and instructor in Missouri's water works short courses; and for his many creditable services to the Section.

Montana Section—JOHN BUDD HAZEN: in recognition of his scientific acumen; his eminent standing in his profession; his generosity of time and talent in all cooperative civic and professional endeavors, particularly concerning public water supply; and for his loyalty and outstandingly fine service to the Section.

New England Section—THOMAS RINGOLD CAMP: for his many contributions to the advancement of hydraulic and sanitary knowledge; for his leadership in the water works profession; and for his skill in the investigation and design of public water supplies.

New Jersey Section—EDWARD ARTHUR BELL: for his continuous interest in the Association; for his active participation and leadership in the affairs of the Section; and for his services to other engineering and professional organizations.

New York Section—EVAN A. SIGWORTH: for his fine combination of technical ability and spirit of helpfulness and cooperation, which has brought about improvements in water quality in many American cities; and for his extraordinary patience, affability, and efficiency in handling the transportation arrangements for the Association's annual convention for so many years.

North Carolina Section—GEORGE SKEVINGTON RAWLINS: for his leadership and advancement of the interests of the Section; for his continuous and energetic promotion of high ethical standards within the profession; and for his untiring efforts in establishing good water works practices through sound engineering and design.

North Central Section—HERBERT SAMUEL GROVE: for his efficient operation and success in improving his city's water system; for his loyal interest and leadership in the affairs of the Section; and for his promotional activities in behalf of the water works school for training operators.

Ohio Section—HOMER KNOX: for his outstanding engineering ability, leadership, and guidance in the planning and completion of water works projects in Ohio; his helpful advice in the furtherance of sound water works practices; and his many contributions to the Section.

Pacific Northwest Section—ROY WINCHESTER MORSE: in recognition of his high competency as an engineer; and for his administrative abilities, particularly as exemplified so outstandingly in his management of the Association's 1954 Convention in Seattle.

Pennsylvania Section—HARRY JAMES KRUM: in recognition of his many years of efficient and successful operation and improvement of his community's water system; and for his active and constructive participation in the affairs of water works operators.

Rocky Mountain Section—BENJAMIN GRIFFITH DAVIS: for his long and outstanding services to the city of Rawlins, Wyo., in the development and preservation of its water supply; for his constant support of the Rocky Mountain Section since its formation; and for so generously sharing his specialized knowledge with other water works men.

Southeastern Section—JOHN FRANKLIN PEARSON: In recognition of his long and distinguished service as manager of public utilities of the city of Orangeburg; his planning and developing of its water supply; his inspiration to the younger men of the water works profession; and his leadership in the Section.

Southwest Section—FRED LEON McDONALD: for his outstanding work in developing an improved licensing plan which has been nationally recognized and suggested as standard; for his untiring and successful promotion of enthusiastic district meetings; and for his unselfish advancement of the water works profession.

Virginia Section—XENOPHON DUKE MURDEN: in recognition of his individual efforts as past officer of the Virginia Section and as its national director; and for his conscientious and efficient management of the Portsmouth Water Department.

Schedule of Conference Papers and Reports

Joint Boiler Feedwater Research Committee—9:30 AM—June 13, 1955

Merits, Defects, and Performance of Monobed and Two-Bed Demineralizing Systems....... H. E. Bacon, L. G. Von Lossberg, and S. T. Powell
Suspended Solids—Their Identification, Significance, and Control.......... S. K. Adkins and B. J. Wachter
Corrosion Problems in Small Heating Boilers.......... H. F. Hinst

Open Session—Water Works Administration Committee—9:30 AM—June 13, 1955

Committee Progress Reports
- Safety Practices.......... R. J. Faust
- Job Classifications.......... R. S. Millar
- Use of Water in Air Conditioning.......... F. C. Amsbary Jr.
- Water Main Extension Policy.......... L. S. Finch
- Water Service Rules and Regulations.......... J. H. Murdoch Jr.
- Water Utility Accounting.......... J. J. Barr

Water Purification Division—2:00 PM—June 13, 1955

Effect of Various Types of Water on Nonferrous Metals.......... Lee Streicher
Problems in Estimating Fluorides in Water.......... H. P. Kramer
Panel Discussion—Biological Infestation of Purified Water
- Introduction.......... M. P. Crabill
- Bloodworms.......... J. K. G. Silvey
- Snail and Clam Infestation.......... W. M. Ingram and C. M. Palmer
- Summary.......... M. P. Crabill

Effect of Disinfection Dosages of Chlorine on New Water Mains.......... William Yegen

Water Resources Division—2:00 PM—June 13, 1955

Regional Water Supply Planning for North Central Ohio.......... Paul Belcher
- Discussion.......... Wendell R. LaDue

Our National Water Resources Policy.......... Clarence A. Davis
Panel Discussion—1955 State Legislation Concerning Water Resources
- Introduction.......... Stephen W. Bergen
- North Atlantic.......... C. H. Capen
- South Atlantic.......... G. S. Rawlins
- Ohio Valley.......... C. H. Bechert
- Missouri Valley.......... T. W. Thorpe
- Southwest.......... M. B. Cunningham
- Pacific Coast.......... L. J. Alexander

Water Resources Division—9:30 AM—June 14, 1955

Development of a Fresh-Water Barrier in Southern California for the Prevention of Sea Water Intrusion....Finley B. Laverty
Recharge Operations of the Upjohn Company at Kalamazoo, Mich....W. H. Sisson
Streams Plus Wells Make Economical Industrial Supply....R. D. Wilson
Discussion....Clifford Fore

Water Purification Division—9:30 AM—June 14, 1955

Panel Discussion—Unique Features in Water Treatment Plant Design....
Led by H. O. Hartung.
W. W. Aultman, C. M. Bach, Marshall Houghn, and T. M. Riddick
Recording Instrumentation in Water Treatment Plants....Oscar Gullans
Effects of Detergents on Water Treatment....J. C. Vaughn
Discussion....Charles D. Gates

Water Purification Division—2:00 PM—June 14, 1955

The Magnitude and Treatment of Nuclear-Reactor Wastes....W. A. Rodger
General Review—Studies of Water Treatment Methods to Prevent Radioactive Pollution....
H. Gladys Swope
Instrumentation for Radioactive-Pollution Studies....H. E. Pearson
1955 Studies of Radioactive Fallout....Rolf Eliassen and R. A. Lauderdale

Water Resources Division—2:00 PM—June 14, 1955

Panel Discussion—Controlled Draft From Reservoirs
New York Metropolitan System....Edward J. Clark
An Industrial Water Supply Reservoir....A. D. Henderson and A. S. Toth
Equating Surface and Underground Storage....R. A. Hill
Water Management—Another Necessity in Modern Industry....K. S. Watson

Management Division—9:30 AM—June 15, 1955

Panel Discussion—The Problem of the Suburbs and Public Services
Introduction....Abel Wolman
Your Government's Stake in the Provision of Adequate Community Facilities....
John C. Hazeltine
The Public Service Commission's Viewpoint....O. P. Deuel
The State Sanitary Engineer's Viewpoint....W. F. Shephard
The Fire Protection Problem....Kenneth J. Carl
Resume....Abel Wolman

Distribution Division—9:30 AM—June 15, 1955

Design of Cement-lined and Coated Steel Pipe....E. S. Cole
Electrical Inspection of Coatings on Steel Pipe....S. Mark Davidson
New Developments in Tests of Coatings and Wrappings....G. E. Burnett and P. W. Lewis
New Standards for Deep Well Turbine Pumps....M. H. Owen and P. H. Brown

Research Projects—Progress and Planning—2:00 PM—June 15, 1955

Effects of Physical Environment on Water Mains....
W. D. Hurst, R. F. Legget, and A. Baracos
Effect of Water Treatment on Water Mains....T. E. Larson
Chromium and Cadmium in Water....Clarence F. Decker
Public Health Service Research Grants in the Field of Environmental Health, Including Water Supply....Irving Gerring
Report of AWWA Committee on Water Works Research Needs....Martin E. Flentje

Management Division—2:00 PM—June 15, 1955

Electrical Reliability Requirements for the Water Plant...E. O. Potthoff and N. L. Hadley
Selecting Adequate Electric Switching Equipment............................J. P. Kesler
Modernizing Chicago's Pumping Stations....................O. B. Carlisle and J. L. Weeks
Progress in Tunnel Construction for Central District Filtration Plant at Chicago...........
George S. Salter

Management Division—9:30 AM—June 16, 1955

A Forecast of Metropolitan Chicago's Water Needs.........................L. R. Howson
Water Supply Industry Safety—US Labor Department Survey......George R. McCormack
A Successful Safety Program...J. W. McFarland
Discussion...Thomas F. Allen
Modernizing the Management of Chicago's Water Department................J. W. Jardine
Getting Your Customers on Your Team Through Public Relations......Joseph S. Rosapepe

Distribution Division—9:30 AM—June 16, 1955

Pipelines Through Easements...Burton S. Grant
Joint Discussion—Pumping Stations in Residential Areas
Long Island...Peter Ley
California..L. A. Hosegood
The Solution Effects of Water Upon Cement and Concrete Linings of Water Mains..........
M. E. Flentje and R. J. Sweitzer
Discussion...P. S. Wilson
A Fifteen-Year Exposure Test on Three Types of Distribution Mains.........M. J. Shelton

Water Purification Division—10:00 AM—June 16, 1955

Task Group Reports..................................R. L. Derby, A. T. Dempster, L. L. Hedgepeth, J. E. Kerslake, J. B. Miller, and J. C. Zufelt

Management Division—1:30 PM—June 16, 1955

Ready-to-Serve Charges for Private Fire Protection.........................L. R. Hanson
Discussion..Louis E. Ayres
Discussion..R. H. Ellis
Service Charges for Air Conditioning......................................W. V. Weir
Panel Discussion—The Lawn Sprinkling Load.....................A. D. Henderson, E. F. Tanghe, L. S. Finch, and M. P. Hatcher

Open Session—Water Works Practice Committee—2:00 PM—June 16, 1955

Committee Progress Reports
Reinforced Concrete Pipe..E. W. Whitlock
Butterfly Valves...F. G. Gordon
Steel Pipe...H. A. Price
Wet-Barrel Hydrants..J. W. Trahern
Open Discussion—Oil Line River Crossings

Papers Scheduled at 1955 Section Meetings

THERE follows a summary listing of papers scheduled for presentation at 1955 Section Meetings. The dates of the Section Meetings from 1951 to 1955 and the locations for 1955 are listed on page 1240. Section officers who were elected at meetings held during 1955 are listed on page 2 P&R in the front of this issue. The programs are listed alphabetically by Sections, without regard to the date of presentation.

Alabama-Mississippi Section—October 30–November 2, 1955

Address of Welcome . . . . . *Mayor* Laz Quave
Pitfalls of Utility Financing . . . . . Carl Trauernicht
Engineer's Responsibility to a Client . . . . . O. B. Curtis Sr.
Mechanization of Water Utilities . . . . . Fred Scott
Conservation of Our Water Resources . . . . . Irving E. Anderson
Public Relations . . . . . J. M. Phillips
Wells . . . . . W. S. Lyles
Panel Discussion—Wells . . . . . *Led by* Jack H. Pepper
  Engineering . . . . . William Johnson
  Drilling . . . . . Fred Sutter
  Sanitation . . . . . Robert A. Gerber
  Cost . . . . . W. S. Lyle
Panel Discussion—Meters . . . . . *Led by* Tip H. Allen
  Why Utilities Should Test and Repair Their Own Meters . . . . . E. E. Love
  Why Utilities Should Not Test and Repair Their Own Meters . . . . . J. R. Williams
Tank Maintenance . . . . . Clarence D. Lamon
Water Distribution Problems . . . . . Clifton C. Williams
Forum . . . . . *Led by* C. M. Mathews
  Advertisement . . . . . W. E. Hooper
  Billing Practices . . . . . Raymond White
  Maintenance Records of Equipment . . . . . W. H. H. Putnam
  Water Shortage . . . . . W. H. Gilmore
  How to Increase Rates . . . . . W. P. Gearhiser

Arizona Section—April 14–16, 1955

Address of Welcome . . . . . *Mayor* Paul Gaumer
Response . . . . . Phil J. Martin Jr.
Excavation and Backfill
  Owner's Viewpoint . . . . . George T. Grove
  Contractor's Viewpoint . . . . . John T. Young
Adult Education . . . . . John C. Park
Lightning Protection for Water and Sewage Works Equipment . . . . . Earl S. Prud'homme
Proper Liability Insurance Coverage for Utilities
  Insurance Company Viewpoint . . . . . W. J. McKinnon
  Utilities Management Viewpoint . . . . . Ralph F. Thompson
Role of Corporation Commission on Water Utilities . . . . . Bernard Brown
How to Obtain the Friction Coefficient of Existing Pipelines . . . . . Dave Harmon
Keeping Current With Specifications . . . . . Loring E. Tabor
Ground Water Situation in Arizona . . . . . Samuel F. Turner
Problems of "Tin Pipe Utility" . . . . . Spencer D. Stewart
Researches on Natural Rainfall . . . . . A. Richard Kassander Jr.

Utility Relocation and Alterations:
Caused by Federal Roads....................Frank C. Amsbary Jr.
Caused by Improvement Districts and City Streets....................John A. Carollo
Operator's Roundup....................Quentin Mees, Ray A. Drain, and John Rauscher
Demonstration of Water Hammer, Using Josam Shock Absorber....................Ted Star

California Section—Regional Meeting—April 15, 1955

Address of Welcome....................*Mayor* Edward V. Dales
Response....................L. J. Alexander
Design Criteria for Distribution Systems....................H. E. Butler
Progress in Ground Water Replenishment....................James H. Krieger
Improving Water System Operation With Telemetering....................Dallas Raasch Jr.
Discussion....................William H. Worsham
Water Works Clinic....................*Led by* William P. Crum

California Section—October 25–28, 1955

Address of Welcome....................*Mayor* H. H. Hendren
Introduction....................Carl M. Hoskinson
Response....................Louis J. Alexander
The Futility of a Bay Barrier....................Raymond A. Hill
Preparation and Painting of Steel Tank Surfaces....................Oscar Goldman
Safety—Is It Important to the Water Works Industry?....................A. S. Webb
Details of Impounding Reservoir Design....................Duncan A. Blackburn
Experience in Use of Plastics....................Harold Yackey
Planning and Expansion of Water Facilities....................F. B. Blanchard
Panel Discussion....................*Led by* George C. Sopp, Leslie A. Hosegood, H. Arthur Price, Joseph D. DeCosta, and Max K. Socha
Behavior of Salt Water Intrusion Under Fresh Water Recharge....................Harvey O. Banks
Tracing Ground Water Movement by Use of Tritium....................Warren J. Kaufman
Current Trends in Treatment Plant Design....................W. W. Aultman
Chlorination of Deep Reservoirs for Taste and Odor Control....................Ray L. Derby
Panel Discussion—Radioactive Fallout; Deterioration of Water Quality Due to Such Practices as Use of Weed Killers; USPHS Drinking Water Standards....................*Led by* P. H. McGauhey, Vinton Bacon, and John Heslep
Solving the Inactive-Record Storage Problem....................William I. Jones
Application of Electronic Machinery in Water Utilities....................
Panel Discussion—Business Management Clinic....................William C. Welmon and Robert G. Gersham
Hoover Commission Task Force....................Ben Moreel
Problems of Interest to the Small Water Works Operator....................John R. Rossum
Symposium—Effects of Softened Water on Water Works Materials and Equipment....................*Led by* L. E. Tabor
Preparation of Engineering Reports for Management....................Bruce McCauley
Panel Discussion—Cost of Water Treatment....................
Water Works Advance....................Frank C. Amsbary Jr

Canadian Section—April 18–20, 1955

Guided Discussion—Water Rate Trends....................*Led by* F. Y. Dorrance
Symposium—Water Supply to Suburban Areas....................T. V. Berry, W. D. Hurst, L. B. Allan, H. P. Stockwell, L. L'Allier, and J. D. Kline
The New Water Supply Line for the City of Quebec....................George Demers
Guided Discussion—The Economics of Meter Repairs....................*Led by* V. A. McKillop
Ozone as Used by French Water Works....................J. C. Bouchard
Guided Discussion—General Water Works Problems....................*Led by* W. R. Godfrey

Chesapeake Section—October 26–28, 1955

Address of Welcome........Thomas Lane
The McIlroy Electric Network Analyzer........E. P. Linaweaver Jr.
The Rehabilitation of the Bryant Street Pumping Station........Claude Sizemore
Long-Range Plans for Expanding Salisbury's Water System........Philip C. Cooper
Status of Water Works Operators' Certification........W. McLean Bingley
Coagulating Aids........A. E. Griffin
Discussion........Edward S. Hopkins
Watershed Control........L. G. Ningard
Discussion........R. C. Willson
Sterilization of New 48-Inch Transmission Main........Dan M. Watt
Discussion........Robert L. Leaverton
Utilities Committee Report........Robert J. McLeod
Panel Discussion—Expansion of Utilities Serving Suburban Developments........
Led by Victor W. Faivre,
Vance F. Rigling, Leon Weiner, and Alfred Machis
Source and Distribution Problems in Water Supply Created by Severe Drought........
L. V. Schuerholz
Discussion........William C. Rasmussen
Civil Defense up to Now........Frank Milani

Cuban Section—December 1–3, 1955

Program not available.

Florida Section—November 6–9, 1955

The Water Works—Pacesetter of Progress........Paul Weir
Where Are We Going in Pollution Control?........L. J. Fontenelli
Report on the Findings of the Governor's Committee on Water Resources........
Byron E. Herlong
Economics of Water Supplies and Sewerage in Florida........L. C. Leedy Jr.
Filtration Rates........John R. Baylis
Iron and Manganese Removal From Municipal and Industrial Water Supplies..V. J. Calise
Value of Standard Methods in Plant Operations........F. W. Gilcreas
Local Interests Act to Conserve Water Resources of the Oklawah Basin........T. B. Jenson
Factors in Citrus Waste Purification........James B. Lackey
Discussion........R. R. McNary
The Ocala Story........G. D. Russell and F. T. Osteen Jr.
The Training Program of the Robert A. Taft Sanitary Engineering Center..H. P. Kramer
Water Requirements of Florida Industries........F. A. Eidsness
Stream Sanitation in Florida........J. W. Wakefield
Tuxedos and Tennis Shoes in Modern Utilities and Industry........John B. Prine
Forum—Planning and Policies for Extending Water and Sewage Facilities Beyond City Limits........*Led by* A. E. O'Neall,
J. M. Baldwin, S. A. Berkowitz, Gordon J. Barnett, and Stanley Sweeney
Problems of Radioactive-Waste Disposal........Conrad P. Straub
Development of Private Utility Companies........J. W. Greenleaf Jr.

Indiana Section—February 9–11, 1955

Drought and Water Shortage in Indiana........C. H. Bechert
Experiences at:
Jasper........Edward L. Lorey
Ferdinand........Carl J. Heim
Milan........T. W. Thompson
Bloomington........J. M. Cason
Conservation Methods for the Reuse of Cooling Water........Howard E. Degler
The Hazards of Radioactivity in Surface Water Supplies........
Robert W. Schmidt and Alfred M. Tenny

Some Taste and Odor Control Experiences in Indiana..................Joseph G. Filicky
  Discussion..A. E. Griffin
Geology of Ground Water in Indiana....................................John B. Patton
Water Is Where You Find It..J. B. Wilson
Reverse-Circulation Drilling..N. E. Gunderson
Current Trends in Water Treatment Plant Design.....L. R. Howson and W. W. Aultman
  Discussion..W. U. Gallaher
Meter Shop Layout...David J. Ford
Back-Siphonage Can Contaminate Your Drinking Water System...........E. J. Zimmer

Iowa Section—October 19–21, 1955

Address of Welcome..*Mayor* Joseph Van Dresser
Response..T. W. Thorpe
National Water Resources Policy.......................................G. H. Hershey
High-Rate Ground Water Recharge......................................Max Suter
Influence of Radioactive-Dust Fallout on Water Supply.................R. L. Morris
Iron Bacteria in Water Supply...M. K. Tenny
Iowa Streams as a Source of Drinking Water............................M. P. Powell
South American Water Supplies...Jack J. Hinman Jr.
Water Works Policies for Suburban Areas...............................C. Kelsey Mathews
Public Relations—What Does the Customer Have a Right to Expect?......D. Y. Caldwell
Panel Discussion—Air Conditioning and Water Usage Problems........*Led by* Roy Ellis, Mark Driftmier, and Harris F. Seidel
Panel Discussion—Operation and Maintenance of Water Works Distribution Systems...... *Led by* J. J. Hail
  Records...Joseph W. Straub
  Meters..Sidney Peterson
  Hydrants and Valves...Francis L. Wehrle
  Elevated-Tank Maintenance...Earl Bagenstos
Question Box..*Led by* George Ahrens

Kansas Section—April 13–15, 1955

Address of Welcome..*City Mgr.* T. E. Chenoweth
Response..Orville Kuran
Report of Kansas Water Resource Committee and Legislative Action......Russell L. Culp
Water Pollution Control—Effects and Responsibilities.................Dwight F. Metzler
The Water Works and City Planning.....................................George C. Ahrens
Panel Discussion—Flushing Water Mains.......................*Led by* Orville G. Kuran, Paul J. Bush, R. S. Fassnacht, James D. Barker, Robert J. Mounsey, A. B. Mawdsley, and Rex Reynolds
Use of Borax Herbicide in Fire Hydrants...............................Roy M. Smith
Providing Approved Water Service......................................Raymond J. Faust
Pictures and Talk About Pumps...R. C. Glasebrook
Panel Discussion—Treatment Problems Encountered in Detergent-bearing Raw Water.... *Led by* Orville Kuran, James Higgins, Claude R. McGahan, and R. J. Hayes
Research Program of the Soap Manufacturers Concerning Detergents in Raw Water.... F. J. Coughlin
Corrosion as Pertaining to Water and Sewage Plants....................H. L. Fuller
Water Pollution Control—One Phase of Water Conservation...............David B. Lee
Experiences With a Recording Register.................................Wayne A. Baxter
Sizing of Meters, Back-Pressure Valves, and Installation..............A. P. Flynn
Panel Discussion—Washing and Maintenance of Rapid Filters......*Led by* A. W. Rumsey, Henry F. Bruner, Dwane I. Eller, Frank E. Willey, Roy F. Bluejacket, and H. Weigand
Panel Discussion—Bolstering Water Distribution Systems for Peak Loads............... *Led by* Don G. McCamant, Jess Carmichael, O. L. E. Haff, Fred D. Diehl, Robert Mounsey, and Robert S. Millar

Kentucky-Tennessee Section—September 12–14, 1955

Address of Welcome....................*Mayor* Fred E. Fugazzi
Response....................Julian R. Fleming
Water and Sewerage Problems in Foreign Areas....................Howard D. Schmidt
Maintenance and Operation of Pumping Equipment....................Charles E. Coleman
Cathodic Protection....................J. A. Lehmann
Panel Discussion—Maintenance, Operation, and Upkeep of Water Distribution Systems...
Led by E. E. Jacobson, B. E. Payne, Earl Graybeal, A. E. Clark, and E. D. Hawkins
Status of Fluoridation in Kentucky and Tennessee
Tennessee....................Jack A. Henshaw
Kentucky....................Nick G. Johnson
Influence of Chlorine, Lime, Alum, and Other Chemicals on the Efficiency of Activated Carbon for Taste and Odor Control....................Al Hyndshaw
Water Supply and Storage....................John L. Thompson
Water Works Operators' Forum....................*Led by* Ralph C. Pickard, Edward L. Johnson, James H. Fry, J. W. McCoy, and J. P. Brownstead

Michigan Section—September 14–16, 1955

Address of Welcome....................*Mayor* George Algoe
Response....................Herschel O. Self
History of the Flint Water Supply....................Herschel O. Self
Water Supply Expansion in Flint....................Louis E. Ayres
Design Features of the Flint Water Treatment Plant....................Stuart B. Maynard
Operating Experiences of the Flint Water Treatment Plant....................Raymond M. Harwood
News of the Field....................John E. Vogt
Peak-Demand Storage....................George G. Schmid
Insurance and Public Liability....................Dorr Hathaway
Experiences in Studying Organic Taste and Odor Substances in Water, Using Carbon Filter Sampling Methods....................F. M. Middleton
Coordination of Social Security OASI With Existing Public Employee Retirement Plans..
A. G. Gabriel
Methods and Procedures of Financing Water Developments....................Harvey A. Kenney
Remote Control in Water Works Operation....................B. L. Soscia and M. E. Rogers
Red-Water Problems and Corrosion Control in Municipal Water Supplies....................
Malvern F. Obrecht
Economics of Recalcining Water Softening Sludge....................Fred Krause

Missouri Section—September 25–27, 1955

Address of Welcome....................*Mayor* Freeman R. Johnson
Report on National Affairs and Trends....................Paul Weir
Soil Mechanics—Useful Tool in Water and Sewage Plant Development....Henry M. Reitz
How to Build Good Public Relations....................Robert A. Willier
Plastics—Their Importance and Their Limitations in Water Treatment Plants and Distribution Systems....................William Hatfield
The Proper Tools for the Distribution System....................Frank Niemeyer
Panel Discussion—Stream Pollution Control—Its Effect on the Water and Sewage Utility
Stream Pollution and Its Control on the National Level....................Gordon E. McCullum
Stream Pollution and Its Control in the Missouri River Basin....................Glen Hopkins
Proposed Stream Pollution Legislation in Missouri....................Robert C. Smith
Stream Pollution Control in Missouri....................Albert W. Happy Jr.
Choosing the Proper Valve for the Job....................J. H. Whisler
The Membrane Filter and Its Application....................Edwin E. Geldreich
The Effect of Detergents on Chemical Treatment of Water....................Paul D. Haney

Montana Section—April 29–30, 1955

Round Table Discussion.......*Led by* John Morrison
Forming Improvement Districts.......Dave Smith
Public Relations.......Frank C. Amsbary Jr.
Municipal Planning.......Claude W. Eyer

Nebraska Section—April 13–15, 1955

Address of Welcome.......*Mayor* Clark Jeary
Response.......Bert Gurney
The Future of the Electrical Industry.......Harold Lutton
Establishing Utility Rates and Service Charges.......W. B. Avery
Public Relations in Our Utilities.......Alex Radin
It's the Little Things That Count.......Larry Clark
Air-Conditioning Water Use Committee Report.......George R. Miller
Some Observations on the Education Mission to Turkey.......Roy Green
Two-Way Radio Communications for Our Utilities.......Paul Feistner
Reports on Conferences and Schools
Diesel Conference.......R. W. Mills
Electric Meter Short Course.......W. E. Minford
Utilities Conference.......Niles H. Barnard
Digest of 1955 Legislative Bills Affecting Our Utilities.......Victor Bremer
Remote Automatic Control of Pumping Equipment.......George Doyle
Development of Deep Well Turbine Pumps.......A. O. Fabrin

New Jersey Section—October 20–22, 1955

Conservation of Ground Water, Long Island, N.Y.......W. Fred Welsch
Recent Flood Experiences in Pennsylvania and New Jersey.......Warren Newman
New Jersey—Twenty Years as a Section of the AWWA.......Harry E. Jordan and Samuel F. Newkirk
Features of the Water Filtration Plant at Johns-Manville Research Center.......G. R. Bell
Simplified and Elementary Distribution System Hydraulics.......Robert J. Sweitzer
Water Revenue Bonds—Asset or Liability.......George I. McKelvey Jr.
Legal Water Works Problems.......Sidney P. McCord Jr.
Round Table Discussion—Short Wave Radio; Replacement of Retired Employees; Problems With Superhighway Construction; Main Flushing Methods.....*Led by* Oscar Newquist

New York Section—April 20–22, 1955

Address of Welcome.......*Mayor* Steven Pankow
The Distribution System—Design and Construction.......George E. Symons
Extensions and Installing Pipe Valves and Hydrants.......Raymond Murray
Testing and Disinfecting Mains.......Joseph L. Shed
Further Studies of the Significance of the Coliform Test in Relation to Enteric Virus Pollution of Water.......F. W. Gilcreas and Sally M. Kelly
Some Recent Experiences in Taste and Odor Control.......A. Y. Hyndshaw
Maintaining Capacity of Water Mains.......J. A. Frank
Round Table Conference.......*Led by* Nelson M. Fuller

New York Section—September 7–9, 1955

Water Works School.......*Led by* George E. Symons
The Distribution System.......George E. Symons
Water Main Cleaning.......John G. Copley
Meter Testing.......John Schmidt
Pension Plans and Social Security.......H. Eliot Kaplan
Proposed Panther Mountain Dam and Its Effect on Water Supply.......Levi Gaylord
Round Table Conference.......*Led by* Nelson M. Fuller

North Carolina Section—November 14–16, 1955

Address of Welcome..*Mayor* Marshall C. Kurfees
The Development of the Stream Sanitation Program for the Yadkin River Basin...........
E. C. Hubbard
Rainfall Intensity Frequencies in North Carolina....................Charles Smallwood Jr.
Chemical Quality of Ground Water Supplies in North Carolina............G. A. Billingsley
The Occurrence of Ground Water in North Carolina....................Harry E. LeGrand
Relocation of Utilities for Highway Improvements......................George S. Rawlins
Discussion.......W. M. Franklin, Stanford E. Harris, W. M. Lybrook, and T. E. Hinson
Symposium—Water Works Problems.............................*Led by* David Tobin
Infiltration Survey..E. M. Johnson
One Case History—Copper Dissolution Caused by Stray Electric Currents....R. E. Ebert
Accidental Contamination of a Potable Water Supply by Octyl Alcohol....F. R. Blaisdell
Hurricane Damage to a Water Utility..................................C. F. Churchill

North Central Section—October 5–7, 1955

Address of Welcome..*Mayor* Eric G. Hoyer
Response..Howard J. Sowden
Activated Silica and Water Conditioning...A. E. Griffin
Communicable Diseases and the Public Water Supply....................Gaylord Anderson
Water Distribution System Records.................................George F. LaRoche
Water Supply in Pakistan...George R. Jacobson
Missouri Basin Development..Wendell E. Johnson
Panel Discussion—Training of Water Works Personnel.......*Led by* George J. Schroepfer,
C. C. Ludwig, Frank L. Woodward, Lawrence E. LaLonde, and Willis Van Heuvelen
Water Hammer and Its Causes, Magnitude, and Prevention.....................John Fredin
Radioactive-Material Fallout and Its Effect on Public Water Supplies......Simon Kinsman
Water Works Deficiencies...Otto E. Brownell
Sioux Falls' New Water Plant...John N. Browning
Panel Discussion—Air Conditioning..................................*Led by* J. H. Svore,
A. B. Algren, Francis McNeary, and Leonard N. Thompson

Ohio Section—September 21–23, 1955

Address of Welcome.......................................*Mayor* Maynard E. Sensenbrener
Revaluation of Water Supply Protection in Case of National Emergency..................
Richard L. Woodward
Water Laws and Water Rights......................................C. William O'Neil
Review of the Tenth Edition of *Standard Methods*..........................T. E. Larson
Pipe Forum
Cast Iron..Wallace T. Miller
Asbestos-Cement..Paul A. Harlamert
Prestressed Concrete...Harry S. Price
Operating Problems—General Discussion..............................*Led by* M. W. Tatlock
Multiple Use of Water Reservoirs.................................Charles A. Dambach
Use of Newer Types of Valves—Butterfly, Cone, Ball...................Jasper W. Avery
Panel Discussion—Industrial Water Use
Oil...Oliver J. Zandona
Distillery...Stuart Schott
Paper..R. M. Morris Jr.
Steel..C. W. Yeager
Fire Protection Problems Involved in Undersized Mains.................Harry L. Kreiger
Effect of Iron on High-Capacity Zeolite....................................Edgar G. Will
Recarbonation of Lime-softened Water by Sodium Bicarbonate.............Willard Harper
The Hoover Dam..Ben K. Bare
The Big Walnut Treatment Plant...Nye Grant

Pacific Northwest Section—May 19–21, 1955

Address of Welcome.. *Mayor* Gilbert Burns
Response.. Winston H. Berkeley
Radioactivity and Fallout.. V. P. McNamara and B. G. Lake
The Teays River Valley.. Frank C. Amsbary Jr.
A Water Resources Program for Washington.. W. A. Galbraith
Water Supply Problems in the Columbia Basin.. Don E. Gray
Water on Ice.. A. J. Alter
Experiences With the McIlroy Pipeline Analyzer on Water Supply Systems..
Charles L. Barker and Ed Whitman
Panel Report—Short Schools and Certification.. *Led by* R. O. Sylvester, Fred Merryfield, Glenn D. Bowen, Gilbert Dunstan, E. J. Weathersbee, Emil C. Jensen, and Tom M. Smith
The Seattle Safety Program.. Larry Moll
Water Rates and Ratemaking.. Harold S. Shefelman
Panel Discussion—Water Supply for the Growing Community.. *Led by* Carl E. Green, Paul H. Meyer, Gordon R. Hoover, Walter H. Smith, George R. Fisher, Lloyd T. Keefe, and R. J. Abbey
Qualitative and Quantitative Studies on Infiltrated Water..
Eugene W. Slitch and Robert Yale
Fluoridation Committee Report.. *Led by* Herb C. Clare
Benefits.. Francis Walters
Application.. R. C. Smolinski and Warren C. Westgarth
Costs.. Vaughn Anderson

Pennsylvania Section—May 4–5, 1955

Use and Conservation of Water Resources.. Richard D. Hoak
Panel Discussion—F.F.F. (Fluoridation 'Fifty-Five).. *Led by* Robert J. Trace, L. D. Matter, and Gerald J. Cox
Description of Purification Plant of the South Pittsburgh Water Company.. C. E. Towbridge
Algae Control With Chlorine Dioxide.. Walter C. Ringer Jr. and Sylvester Campbell
Utilization of Waste Pickling Acid in Potable Water Treatment.. J. S. Gettrust
Typhoid in Westmoreland and Allegheny Counties..
Maurice A. Shapiro and Horace M. Zezon
Air-Conditioning Water Rate Schedule.. W. Victor Weir
Discussion.. G. E. Arnold and Wendell R. LaDue
Research in Water Works Field.. Martin E. Flentje

Rocky Mountain Section—September 19–21, 1955

Address of Welcome.. *Mayor* Carroll S. Mohr
Response.. T. J. Eaton
Advanced Techniques in Bacteriological Water Analysis..
Report on Underground Water Control and Legislation.. George Baley
Instrumentation.. Frank Mascitti
Importance of Auxiliary Water Supplies.. W. F. Turney
Panel Discussion—Specifications of Water Main Materials
Concrete Pipe Specifications.. William B. Freeman
Cast-Iron Pipe Specifications.. James B. Hill
Steel Pipe Specifications.. G. H. Garrett
Asbestos-Cement Pipe Specifications.. Jack Davis
Importance of Future Planning Using the Master Survey Plan and Finance Forecasting....
V. A. Vaseen
Problems Involved in Supplying Water to Subdivisions and Sanitary Districts..
Ray L. Sherard and Arthur E. Williamson
Relation of Industrial Waste to Cost of Water Treatment.. William N. Gahr
Panel Discussion—Water Works Problems.. *Led by* T. J. Eaton

Southeastern Section—March 20–23, 1955

Address of Welcome....*Mayor* W. Lee Mingledorff
Response....William C. Bowen
Panel Discussion—The Drought of 1954
Effects on Streams in Georgia....M. T. Thomson
Effects on Streams in South Carolina....A. E. Johnson
Effects on Water Supplies in Georgia....W. B. Williams
Effects on Water Supplies in South Carolina....T. A. Kolb
What of the Future?....B. M. Hall Jr.
Water Control Policies....Carl P. Guess Jr.
An Opportunity for Your Water Department....A. O. Putnam
Seven-Year Operation of the Savannah Water Treatment Plant....R. R. Adams
Activated-Silica Sols in Water Purification....A. B. Middleton
Modern Concepts of Water Conditioniing....A. E. Griffin
Panel Discussion—Ground Water in the Coastal Plain of Georgia and South Carolina
Georgia....S. M. Herrick
South Carolina....G. E. Siple
The Savannah Area, With Special Reference to Salt Water Encroachment..M. A. Warren
Pneumatic Control Systems as Applied to Water Works....Frank Mascitti

Southwest Section—October 16–19, 1955

Address of Welcome....*Mayor* J. Ed Kuykendall
Response....John E. Williams
Water Boards and Their Advantages....Martin C. Giesecke
The History of San Antonio's Water Supply....C. Stanley Banks
The Regimen of Edwards Water....William F. Guyton
San Antonio's Production and Distribution System....Robert A. Thompson Jr.
Panel Discussion—What Makes Water a Problem?....*Led by* Henry J. Graeser Jr.
Men....Mary Frances Boothe
Materials....J. R. Hendrick
Money....Henry Graeser
State Water Authority Trends....Marvin W. Melton
A Progress Report on Saline Water Conversion....Louis Koenig
Results of Cloud-seeding Operations to Augment Municipal Water Supply...Irving P. Krick
Public Relations and Opportunity for Your Water Department....A. O. Putnam
Valves for Water Works Systems....Frank C. Fromherz
Valve and Hydrant Maintenance and Inspection Methods....R. L. Lawrence
Panel Discussion—Service Connection and Meter Setting Practices..*Led by* James E. Owen, Curtis C. Harlin Jr., and John S. Stiff
Distribution System Flow Problems....L. M. Haupt
Economic Factors of High-Rate and Conventional Water Treatment....H. R. Fosnot
Radio Use in Water Utility Operations....C. L. Pringle
Standby Power for Water Works Systems....R. E. L. Johnson
Supplies and Equipment for Water System Maintenance....Bob L. Rimmer
Seventy Years of Progress in Public Water Supply....V. M. Ehlers

Virginia Section—November 3–5, 1955

Plastic Pipe in Water Service....Garland S. Sydnor Jr.
Culpeper's Drought Experience....R. W. Huffman
How Portsmouth Regained Transmission Main Capacity by Cleaning and Cement Lining .. J. A. Frank and A. G. Perkins
Virginia's Annual Short School for Operators....J. D. Eye
Radioactive Fallout in Northern Virginia, 1954–55 ....H. N. Lowe Jr.
Report of Advisory Committee on State Water Problems....W. Martin Johnson
Stream Flow Regulation: Cost and Economics....Richard Hazen
Panel Discussion—New Water Construction in Virginia....*Led by* H. F. Knoell

West Virginia Section—October 20–21, 1955

Distribution System Problems
Water Hammer........S. Logan Kerr
Leak Detection........Walter Bisler
Municipal Economics Through Automation........D. P. Gilbertson
Trials and Tribulations of a Realtor in Obtaining Water and Sewer Service From a Municipality........S. L. Bracken
Looking Ahead—Water Supply and Waste Treatment Problems in the Atomic Age........Richard L. Woodward
Modern Mapping Techniques........Robert A. Cummings Jr.
The Consulting Engineer's Responsibility After Construction of a Plant Has Been Completed Edward F. Twomey
Raising Our Sights Toward Greater Conservation of Our Water Resources..Ellis S. Tisdale
Problems of Orphan Water Systems........John H. Millar
Putting Water on Paper........Eric F. Johnson
Highway Relocation Costs........Hugh Hetzer
The Diagnosis of Corrosion Problems........V. V. Kendall
Recent Improvements to the Clarksburg Water System........James A. Romano

Wisconsin Section—September 21–23, 1955

Address of Welcome........*Mayor* Frank P. Zeidler
The Eau Claire Water Supply........Neal W. Bartholomew
Green Bay's Quest for a Permanent Water Supply........Louis R. Howson
Panel Discussion........Walter A. Peirce, O. J. Muegge, and George M. Galloway
Economic Replacement of Pumping Units and Equipment........Joseph Schalk
Fitting a Deep Well Pump to the Well........Robert P. Schirf
Panel Discussion........Philip S. Davy, Russell Davison, and Jack L. Nash
Practical Water Metering Procedure........Joseph H. Kuranz
Main Breaks in the Former Town of Lake........Elmer W. Becker
Panel Discussion........Francis Kuckuck, Harold Bugg, William Hammann, Oliver H. Becker, and James A. Snow
Application for Certificate of Authority for Plant Improvements........William Kuehlthau
Water Works Safety Program........Raymond J. Faust
Panel Discussion........Arthur J. Jark, Verne A. Somers, and William Hanson

Section Membership at Time of, and Total Attendance at, Section Meetings—1951–1955

Section	1951		1952		1953		1954		1955	
	Membership	Attendance	Membership	Attendance	Membership	Attendance	Membership	Attendance	Membership	Attendance
Alabama-Mississippi	163	181	169	100‖	177	182	189	311	206	257
Arizona	72	154	71	173	72	41	76	199	68	157
California§	1,028	1,252	1,044	1,434	1,084	1,126	1,193	1,709	1,291	1,037
Canadian§	531	516	582	756	581	617	608	848	629	714
Chesapeake	247	119	241	250	247	224	248	210	258	211
Cuban	65	52	73	52	72	32	69	#	54	*
Florida	300	282	306	400‖	327	287	328	305	342	306
Illinois	470	348	475	418	482	407	504	474	527	‡
Indiana	289	299	333	392	330	386	332	399	392	475
Iowa	115	195	119	182	121	178	133	191	137	286
Kansas	139	186	187	*	206	170	220	191	229	208
Kentucky-Tennessee	186	202	186	252	186	203	189	294	201	259
Michigan	294	225	319	242	349	164	386	263	411	236
Missouri	181	202	190	225	189	242	198	260	206	230
Montana	62	120	59	168	58	107	55	117	57	76
Nebraska	64	158	75	152	82	224	95	200	94	164
New England	205	†	211	†	218	†	218	†	225	†
New Jersey	379	276	411	311	414	318	436	340	435	313
New York§	715	340	743	375	741	355	805	420	826	315
North Carolina	178	242	182	261	188	294	191	255	202	281
North Central**	216	167	230	179	229	166	241	179	238	162
Ohio	392	320	400	297	403	252	445	406	468	251
Pacific Northwest	299	257	315	267	345	346	441	‡	440	293
Pennsylvania	419	214	433	215	455	204	465	234	493	255
Rocky Mountain	141	128	157	122	156	125	170	100	171	94
Southeastern	181	‡	190	220	203	205	246	313	267	325
Southwest	702	708	779	582	938	803	945	681	1,047	850
Virginia	177	84	183	237	179	226	188	230	192	237
West Virginia	94	156	98	130	102	120	103	212	100	152
Wisconsin	164	305	176	314	181	288	182	316	190	291

* No record of attendance.
† No regular meeting scheduled. Membership given as of dates of conferences.
‡ Regular meeting canceled. Business meeting held at annual conference.
§ Only one of section's meetings recorded here.
‖ Joint meeting.
\# Meeting canceled.
** Formerly Minnesota Section.

Section Meetings—1951–1955

Section	*1951*	*1952*	*1953*	*1954*	*1955*	*Meeting Place—1955*
Alabama-Mississippi	Sep. 24–26	Nov. 16–19	Oct. 4–7	Oct. 24–27	Oct. 30–Nov. 2	Biloxi, Miss.
Arizona	Mar. 28–31	Apr. 3–5	Apr. 16–18	Apr. 22–24	Apr. 14–16	Chandler, Ariz.
California	Apr. 6*	Apr. 17–19*	——	Apr. 9*	Apr. 15*	Riverside, Calif.
	Oct. 23–26	Oct. 28–31	Oct. 27–30	Oct. 26–29	Oct. 25–28	Sacramento, Calif.
Canadian	May 21–23	May 26–28	Apr. 6–8	Apr. 12–14	Apr. 18–20	Quebec, Que.
	——	Oct. 21–22†	Sep. 21–22†	Oct. 4–5†	Oct. 17–18†	Sydney, N.S.
Chesapeake	Oct. 31–Nov. 2	Oct. 29–31	Oct. 28–30	Oct. 27–29	Oct. 26–28	Washington, D.C.
Cuban	Nov. 29–Dec. 1	Dec. 4–6	Dec. 3–5	——	Dec. 1–3	Havana, Cuba
Florida	Oct. 28–31	Nov. 16–19	Oct. 11–13	Nov. 7–10	Nov. 6–9	Orlando, Fla.
Illinois	Mar. 28–30	Mar. 26–28	Mar. 18–20	Mar. 17–19	——	——
Indiana	Feb. 7–9	Feb. 13–15	Feb. 11–13	Feb. 10–12	Feb. 9–11	Indianapolis, Ind.
Iowa	Oct. 25–27	Oct. 23–25	Oct. 14–16	Oct. 13–15	Oct. 19–21	Des Moines, Iowa
Kansas	Apr. 11–13	May 3	Apr. 22–24	Apr. 7–9	Apr. 13–15	Hutchinson, Kan.
Kentucky-Tennessee	Sep. 17–19	Sep. 15–17	Sep. 21–23	Sep. 20–22	Sep. 12–14	Lexington, Ky.
Michigan	Sep. 19–21	Sep. 24–26	Sep. 3–4	Sep. 15–17	Sep. 14–16	Flint, Mich.
Missouri	Sep. 30–Oct. 2	Sep. 21–23	Sep. 27–29	Sep. 26–28	Sep. 25–27	Joplin, Mo.
Montana	Apr. 20–21	Apr. 11–12	Apr. 24–25	Apr. 23–24	Apr. 29–30	Butte, Mont.
Nebraska	Apr. 19–20	Apr. 17–18	Apr. 16–17	Apr. 22–23	Apr. 13–15	Lincoln, Neb.
New England	——	——	——	——	——	——
New Jersey	Oct. 25–27	Oct. 23–25	Oct. 22–24	Nov. 4–6	Oct. 20–22	Atlantic City, N.J.
New York	Apr. 5–6	Apr. 17–18	Apr. 16–17	Apr. 22–23	Apr. 20–22	Buffalo, N.Y.
	Sep. 13–14	Sep. 4–5	Sep. 9–11	Sep. 9–10	Sep. 7–9	Upper Saranac Lake, N.Y.
North Carolina	Nov. 12–14	Nov. 10–12	Nov. 9–11	Nov. 8–10	Nov. 14–16	Winston-Salem, N.C.
North Central‡	Sep. 12–14	Sep. 9–12	Sep. 1–5	Oct. 6–8	Oct. 5–7	Minneapolis, Minn.
Ohio	Sep. 27–28	Sep. 18–19	Sep. 10–11	Sep. 22–24	Sep. 21–23	Columbus, Ohio
Pacific Northwest	May 17–19	Apr. 24–26	Apr. 16–18	——	May 19–21	Yakima, Wash.
Pennsylvania	Sep. 19–21	Jun. 18–19	Jun. 17–19	Jun. 23–25	May 4–5	Pittsburgh, Pa.
Rocky Mountain	Sep. 24–25	Sep. 15–17	Sep. 21–23	Nov. 9–10	Sep. 19–21	Laramie, Wyo.
Southeastern	——	Mar. 24–26	Mar. 23–25	Mar. 29–31	Mar. 20–23	Savannah, Ga.
Southwest	Oct. 14–17	Oct. 12–15	Oct. 18–21	Oct. 17–20	Oct. 16–19	San Antonio, Tex.
Virginia	Nov. 7–9	Nov. 5–7	Nov. 4–6	Nov. 3–5	Nov. 3–5	Roanoke, Va.
West Virginia	Oct. 4–5	Oct. 2–3	Sep. 3–4	Nov. 8–9	Oct. 20–21	Clarksburg, W.Va.
Wisconsin	Sep. 25–27	Sep. 16–18	Sep. 22–24	Sep. 28–30	Sep. 21–23	Milwaukee, Wis.

* Regional meetings. † Maritime Branch. ‡ Formerly Minnesota Section.

Subject Index

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Author Index

Binding the Year's Journals

Through the cooperation of the Library Binding Institute, an organization of binderies which specializes in binding publications into volumes, arrangements have been made to give information and assistance to AWWA members who want to have their JOURNALS bound. This work may be done in accordance with standards of materials and construction required for durability, service, and accessibility by college, reference, and public libraries. The American Library Association and the Library Binding Institute have cooperated in promulgating "Minimum Specifications for Class A Library Binding" based on research and production and performance experience.

A committee of the American Library Association has certified responsible and reliable library binderies which have proved able to meet these specifications. To obtain standard quality binding, simply request Class A binding at any certified bindery. In obtaining price quotations, state the three dimensions of the volume.

Names and addresses of certified binderies in your area are available from the Library Binding Institute, 501 Fifth Avenue, New York 17, N.Y. Before sending copies to the bindery:

1. Check for missing issues and check each issue for defects, missing pages, etc. Be sure to include the volume index.

2. Tie the twelve issues together carefully so that nothing is crumpled or torn.

3. Write out definite instructions giving your preferences on the following points:

a. Color of binding (one of the following standard colors should be selected: dark green, dark blue, black, brown, or medium red).

b. Whether the advertising sections and/or paper covers are to be bound into the volume.

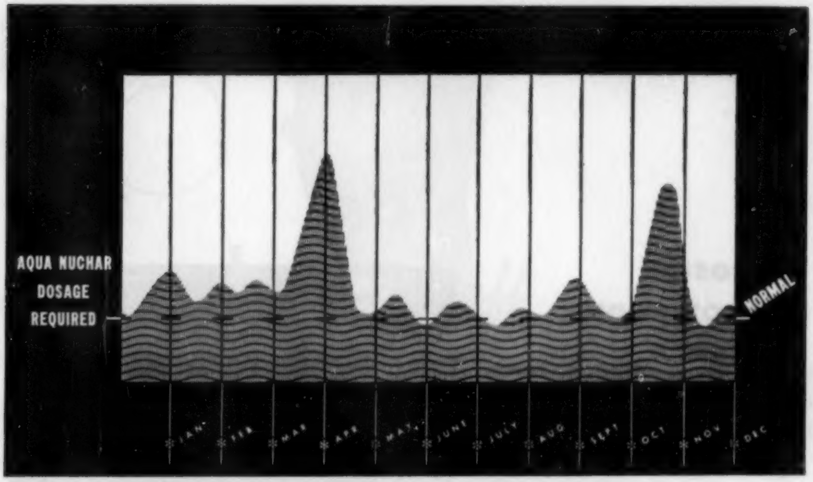
c. An exact copy of the text to be lettered in gold on the backbone. A common form is:

Journal—$1\frac{3}{8}$ in. from top	Vol. 47—$4\frac{1}{4}$ in. from bottom
AWWA—$2\frac{1}{4}$ in. from top	1955—$3\frac{3}{8}$ in. from bottom

d. If you have had JOURNALS bound before and want your set to match as closely as possible, send a previous volume as a sample. If you want an approximate match, send a "rubbing" of the lettering on a previous volume and indicate the color.

If satisfactory arrangements cannot be made, or if there is any difficulty, advise the AWWA office and steps will be taken in cooperation with the Library Binding Institute to assure you proper service.

By arrangement with AWWA, University Microfilms, 313 N. First St., Ann Arbor, Mich., is making a microfilm edition of the JOURNAL available to regular subscribers at a price comparable with the cost of library binding. The cost of the microfilm edition of the 1954 volume was $8.15.



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Whenever taste and odor increase in your water supply it is necessary to use more Aqua Nuchar Activated Carbon. Don't blame the Aqua Nuchar if your dosages are insufficient because it is always the same quality and will adsorb with its usual speed the objectionable algae and trade waste tastes and odors. In addition, constant dosages of Aqua Nuchar will serve as the foundation for a quick increase should a greater requirement arise. However, it must be remembered that when these sudden intensifications in taste are cured and required dosages fall back to normal. the amount of *extra* Aqua Nuchar added must be eliminated.

To show your water plant operators and superintendents the exact amounts of Aqua Nuchar Activated Carbon required, our experts from our Technical Service Department will give a complete Threshold Odor Survey without obligation. Furthermore, they will advise them how to use Aqua Nuchar Activated Carbon with other chemicals. To obtain the palatable water your consumers desire, Industrial is ready to assist.

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Percolation & Runoff

On the brink of its Diamond Jubilee Year, AWWA is now poised for a flying start on the last quarter of its first century. Although the actual birthday won't come around until Mar. 29 and the biggest celebration until the week of May 6–11 in St. Louis, the Association already has big plans for observing the anniversary all through the year. The details of observance have not been worked out fully, but one thing is sure: the celebrating will profit by your participation. If you have an anniversary of your own, you have a "natural" tie-in, for, certainly, the story of AWWA has been the story of your industry. But even if you claim complete anniversarylessness, the fact that you are a member of the oldest and biggest professional organization of water works men in the world is as important to your community as it is to you. On the brink, think!

In the drink, meanwhile, already celebrating its biggest birthday yet, is that other organization of the same street address and objective, which manages, nevertheless, to operate on the principle that "Silent Service Is Not Only Enough . . . But Safer!" We refer, of course, to Editors Anonymous, the group of loosely knit wits which has now completed its eighth year of providing P&R with its *moyen d'etre*—with *beaucoup de* clippings, that is, and other inspiration for unintelligibility such as this.

Inasmuch as this is the eighth December disanonymization, most P&Readers are now familiar with the basis for classifying members of the EA. Lest any wife pick up the issue by mistake, however, it will be well to note that the grades of anonymity here employed are related not (necessarily, at least) to tippling, but to clipping. Thus, in the list below, *Incurable* denotes superscissorian; *Deetee,* chronic cutup; *Shake,* sometime shearer; and *Jitter* extemporaneous exciser:

Incurables

E. L. Filby[8]	W. R. LaDue[6]
R. E. Hansen[4]	J. M. Wafer[8]
M. J. Harper[8]	Henry Wilkens[8]
P. S. Wilson[8]	

Deetees

C. H. Capen[7]	R. L. Tyler[4]
G. E. Symons[8]	W. V. Weir[8]

Shakes

J. M. Diven[8]	Warren Gold[8]
D. N. Fischel[7]	G. J. Manahan

Jitters

G. E. Arnold	L. E. Blakeley[2]
A. E. Berry	C. G. Bourgin
A. P. Black[8]	D. C. Colebaugh

(*Continued on page 36 P&R*)

(Continued from page 35 P&R)

N. M. deJarnette^{4}
G. E. Ferguson^{3}
A. G. Fiedler^{3}
V. C. Fishel
M. E. Flentje^{4}
W. A. Fraser
N. J. Goode^{3}
J. L. Hawkins
R. L. Heck^{2}
W. B. Kirchman^{6}
J. E. Kleinhenz^{3}
Leo Louis^{3}
Malcolm Merritt^{3}
C. E. Painter^{3}
B. E. Payne^{3}
T. M. Riddick^{4}
J. S. Rosapepe^{2}
E. A. Sigworth^{7}
J. F. Zieserl

Together, these innominates have, for as many years as their various powers denote, helped guarantee the continued existence of the less sober portions of these columns. What you owe them for this we hesitate to guess, but we, at least, are anxious to wish them not only Happy Birthday and Merry Christmas, but Many Happy Returns!

Thorndike Saville, dean of New York University's College of Engineering, has been elected president of the Engineers Council for Professional Development. Dean Saville is also president of Engineers Joint Council.

Daniel P. Morse has been named vice-president and general manager of the Indianapolis Water Co., replacing A. O. Norris, who recently resigned. Mr. Morse served as development engineer from 1946 to 1951, leaving in that year to join the engineering and facilities planning department of Eli Lilly & Co. in Indianapolis. He returned to the Indianapolis Water Co. in April 1954 as assistant executive vice-president.

Johns-Manville is splitting its present Industrial Products Div. in three—Pipe Div., Packings & Friction Materials Div., and Industrial Insulations Div.—effective January 1956. Robert F. Orth will be general manager of the new Pipe Div. Mr. Orth, also elected vice-president of Johns-Manville Sales Corp., has been manager of the Transite Pipe Dept. since 1946. The other two new divisions will be managed by Francis J. Wakem and Don L. Hinmon, respectively.

Better water in politics than politics in water, but, after last month's election, we're all for neither in either. What the situation was elsewhere we haven't yet discovered, but here in the New York metropolitan area, it was definitely confused.

In the New York election, for instance, the Panther Mountain Dam issue, involving an amendment to the state constitution to permit flooding of 1,500 acres of the state forest preserve by a flow-regulating dam on the Moose River, was brought before the voters. Supporting the amendment as a boon to flood control, recreation, water supply, and industry were the majority of upstate newspapers and a number of conservation groups, as well as AWWA's New York Section. Opposed, on the basis that the program was an unjustified invasion of the forest preserve for private profit, were the New York City newspapers and another host of conservation and recreation groups. Confused, most voters found "no" the safer vote.

In New Jersey at the same time, a water resources bond issue was finally brought to a vote, but because it was tied to a project that a good many engineers felt was second choice or worse and because the bill submitted for referendum was, in Bill Orchard's words, "illy conceived and poorly drawn," even "expert" opinion was as divided as it was strong. Many of those who were for the bill, including the governor, were for it in spite of its weaknesses. As Governor Meyner

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(*Continued from page 36 P&R*)

pointed out in a last-minute decision to back the bill:

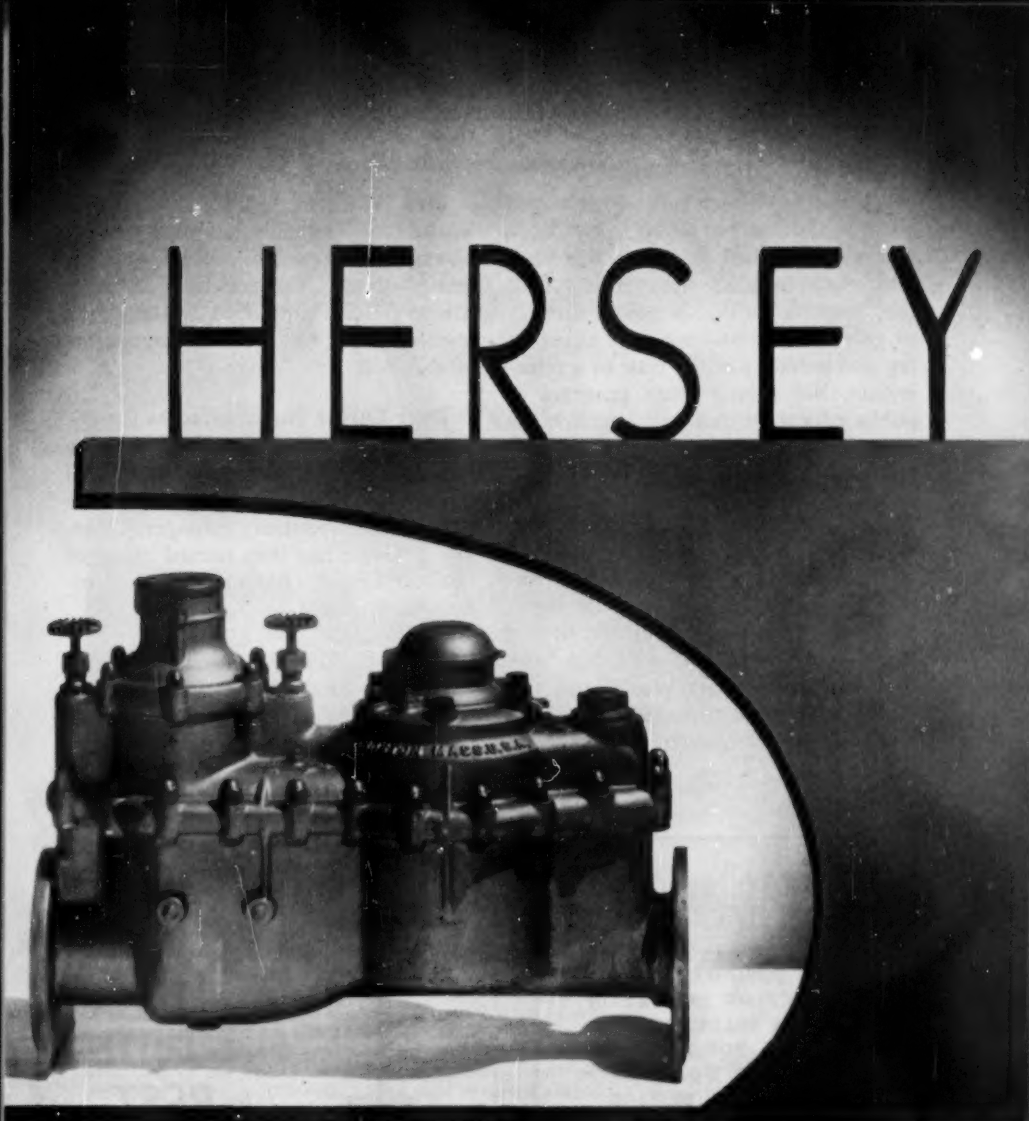
> In the long run, we are going to need all the surface and underground water we can get; we are going to need all the available waters within our state, and we are going to have to tap the Delaware as well. We shall require not just a Chimney Rock or solely a Round Valley; we shall need more than both if we are to expand our economy and satisfy the growing demands of our people.

On the other side, AWWA's New Jersey Section, which has been working hard and long to promote action on the state's water problems decided to oppose the bill on the theory that, no matter how desirable it was to have some action, action that would "put the state in the water business in competition with municipal and private water works" was worse than none at all. Confused, most voters found "no" the cheaper vote.

Similarly, on a local scale throughout the area, Nov. 8 found voters trying to decide on the merits of fluoridation, the need for additional pipeline capacity, or the desirability of more water works facilities 10 or 20 years from now. And, confused, they voted usually for the "safer" or "cheaper" way.

The answer, of course, is education —if not education in toxicology and engineering, then education in weighing the opinions of experts. Only trouble is the experts are so thick these days and so often thickly involved that both sides of every issue can usually muster enough of them to be overwhelmingly convincing. On just about

(*Continued on page 40 P&R*)



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(*Continued from page 38 P&R*)

every one of the ten amendments and one proposition on which New York voters were asked to decide this election, they couldn't miss voting with the "experts." Which points directly to public relations—not just advertising and publicity at the time of a referendum, but a long-range program of public education that will establish the authoritativeness of your own experts and their benevolence of motive before a battle is joined. In other words:

Best water in politics—with wisdom!

First prize for the water works annual report judged best in the international competition conducted by the magazine, *Financial World*, has been awarded to Jamaica Water Supply Co. The company had placed second on four previous occasions.

Mrs. William J. Orchard, wife of Wallace & Tiernan's longtime general manager, died on Nov. 28 after an extended illness. Long as familiar a figure as "Bill" himself at water works meetings, she was a devoted supporter of AWWA.

Dorr-Oliver Inc. announces the appointment of Carlton W. Crumb to the new post of director of technical data and Charles M. Comstock to the position of advertising manager. Harvey J. Goetz has been named manager of Dorr-Oliver (India) Ltd., with offices in Bombay.

Fred J. Myers has been named Hammond Iron Works district sales manager at Warren, Pa. He had previously been with Lukens Steel Co.

(*Continued on page 42 P&R*)

(Continued from page 40 P&R)

The Ivory Tower is what we'd call the six-story glass and aluminum office building recently erected in Grand Junction, Colo.—not because it's secluded, however, nor for the meditation likely to take place inside, but simply because "it floats"—on water, of course. It wasn't fear of floods or of a wet basement that led to the design of this web-footed skyscraper, but the desire to do something about its place in the sun. Thus, the building is mounted on a pivot and rests its weight on a 333,000-gal reservoir, which permits it to revolve a total of 90 deg, turning its heat-reflecting aluminum back to the sun in the summer and its glassy sides to it in winter, all of which constitutes a rather unusual application of water in air conditioning.

This is not the first time that water has acted as a foundation for other than sea-going structures, but the first, no doubt, in which it has been poured as one. All of Mexico City, of course, is really built on water—its underlying soil requiring ten parts of water to one of solids for stability. And some of our West Coast cities have recently been giving evidences of drinking down their own foundations (*see* April 1955 JOURNAL, p. 412), although their sinkage has not yet come close to Mexico City's average of 20 in. per year. With their water sealed in, Grand Junction's waterborne workers will not have to worry about drinking themselves into a hole, but they have been just a little concerned about springing a leak.

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(*Continued from page 42 P&R*)

Meanwhile, with Lever Bros. installed in New York headquarters whose architecture is definitely Lux box, chances ought to be $99\frac{44}{100}$ out of 100 that Procter & Gamble will soon have an Ivory tower of its own.

Roy F. Weston has resigned as sanitary engineer of Atlantic Refining Co. to devote full time to his consulting firm, Weston, Eckenfelder & Assocs., Newtown Square, Pa.

The stuff of life is what we deal in, and it's just about time all of us, at least, recognized the fact. Too long have too many of us let air put on airs. Only the other day, as a matter of fact, in an otherwise fine brochure issued by one of our outstanding West Coast water utilities, we were shocked to read: "Second only to air as the most vital necessity of life." "Second to nothing," we say, and no less an authority than H. G. Wells says it with us in one of the opening chapters of *The Outline of History,* when he points out:

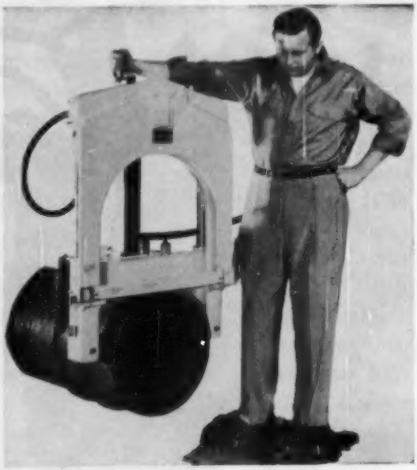
> No creature can breathe, no creature can digest its food, without water. We talk of breathing air, but what all living things really do is to breathe oxygen dissolved in water.

Now, put that in your pipe and pump it!

WANTED
January 1955 *Journals*

If you can spare your copy and it is in good, salable condition, let us know by writing to: *Back Issues Dept., Journal AWWA, 521 Fifth Ave., New York 17, N.Y.* We'll tell you where to send the issue, and we'll pay 50 cents for it.

Pipe cutting in a space 32 in. wide is said to be possible with the "Big Guillotine" power saw made by E. H.



Wachs Co., Chicago. The 312-lb saw, for on-the-job cutting of 10–16-in. cast-iron or steel pipe, has a machined cast-steel V-saddle base that assures a square cut at right angles to the pipe.

The Lansing, Mich., Board of Water & Light Commissioners has taken over the water and sewage disposal facilities of the Landel Metropolitan Dist., which formerly served about 5,000 customers in outlying areas of the city and its suburbs. Acquisition of the \$5,000,000 system by the city was approved earlier in 1955 by the voters as a means of promoting orderly growth.

Fred S. Childs, of Bogert & Childs, Cons. Engrs., New York, has been elected president of the New Jersey Board of Professional Engineers & Land Surveyors. Mr. Childs is now serving his third term in this office.

(*Continued on page 46 P&R*)

(Continued from page 44 P&R)

A real New Yorker was feted at the New Yorker Hotel last month, when some 450 friends and associates of Eugene O. Bauman, chief of the Bureau of Water Register of New York's Dept. of Water Supply, Gas & Electricity, gathered to congratulate Gene on his more than 30 years of service to the city. With the department's commissioner, Arthur Ford, and Chief Engineer Ed Clark on hand to lead off the postprandiations, it was, it is reported, a real dinger of a testimonial, but no more than Gene deserved.

Enoch R. Needles, senior partner of Needles, Tammen & Bergendoff, New York, has been elected president of the American Society of Civil Engineers, succeeding William R. Glidden, assistant chief engineer, Virginia Dept. of Highways, Richmond.

Paul Rittenberg, president of the Passaic Valley Water Commission, died Oct. 23, 1955, in Paterson, N.J., after an illness of several weeks. He was 53. Born in Paterson and graduated from New York University Law School in 1923, he was a member of the law firm of Shavick, Rittenberg & Shavick. He was appointed to the commission in 1953, becoming president in January 1955.

A member of AWWA since 1953, Mr. Rittenberg's professional affiliations included the American, New Jersey, and Passaic County bar associations. He was also active in civic affairs.

Correspondence

Onward Is Upward

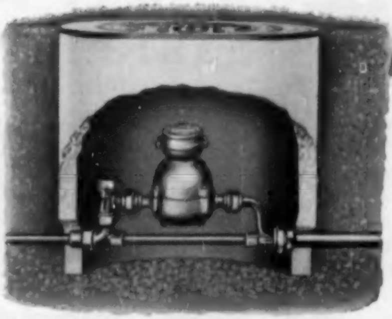
To the Editor:

I have read with interest a paper by Mr. Wade G. Brown on "High-Rate Filtration Experience at Durham," in the March 1955 JOURNAL (p. 243). The comments of Mr. Brown and references to those of Mr. Baylis appear to confirm that the so-called modern rapid sand filter is out-of-date. This has also been my view for several years, but it appears difficult to convince authorities and users of this fact. My experience with conditioning and filtration at Singapore for many years included about 10 years of practical research into the problem and resulted in the development of different methods and plant for this purpose. Much of this modified plant has been in use for 5 years but, to my knowledge, it has not been used elsewhere. My view was (and still is) that *upward* uniform flow should be employed to a maximum extent on all processes including filtration. Upward-flow filters of my design are in use at two swimming pools in Singapore. Two upward-flow filters of approximately 2-mgd (Imp.) capacity have been operating on the Singapore town supply since 1950 and are giving excellent results. These have been operated at rates up to 3 gpm (Imp.) per square foot (equivalent to approximately 3.7 gpm US), and runs and results have been excellent. The maximum loss of head is 13 in.

The following details are given of a run on an upward-flow filter during the month of July 1955:

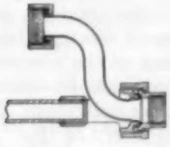
(*Continued on page 52 P&R*)

Save... Time-Money

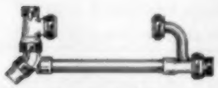


ON WATER METER INSTALLATIONS WITH THE

FORD LINESETTER



Section view of tube end assembly showing double-purpose connection for iron or copper.



Type VEA Linesetter 45° angle inlet for copper. Double Purpose Coupling Outlet.

The Ford Linesetter is as easy to install as a new pipe union in all types of shallow meter settings, with all kinds of meter boxes.

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Correspondence

(*Continued from page 50 P&R*)

Area of filter	580 sq ft
Length of run	345 hr
Average rate of filtration	78,000 gph, or 2.24 gpm/sq ft (Imp.) (2.8 gpm US)
Initial head	2.5 in.
Final head	11.75 in.
Loss of head over filter run	9.25 in.
Performance figure	61,500
Power consumed during run	0.00041 hp/sq ft

Chemical results include: pH, 7.3–7.5; color, 5 Hazen (6 Hazen for a short period when flocculation was incomplete); and iron, 0.20 ppm. Conditioned water varied as follows: pH, from 5.2 to 5.4; color, from 5 to 8 Hazen; and iron, from 0.2 to 0.3 ppm.

Conditioning of water was effected in recently designed upward-flow flocculators and clarifiers, the dosing being lime (approximately 9.0 ppm) and sulfate of alumina (16–24 ppm). Effluent from the conditioning plant was dosed with lime just prior to filtration (8 ppm). Bacteriological results were consistently good throughout the run. On completion of the run, the filter was washed and recommissioned, the initial head being 3 in. Wash water used was approximately 150,000 gal—i.e., 0.5 per cent of amount filtered.

Results on conditioning at one of the main stations (Tebrau in Johore) with the newly designed plant were excellent, using lime and sulfate of alumina. Some of the results are as follows: average rates of flow—flocculators, 1.37–2.74 gpm (Imp.) per square foot; clarifiers, 0.46–0.55 gpm (Imp.) per square foot. Raw river water varied in color from 30 to 400 Hazen, but the effluent from the clarifiers was maintained at 5 Hazen. The filters are of the downward-flow type, with special underdrains, no subgrade, and coarse sand. Runs varied from 25 to 50 hr and average rate of flow was 2.5 gpm (Imp.) per square foot. Output of the station was approximately 15 mgd (Imp.) during July 1955.

These results appear to indicate that conditioning and filtration plant can be designed to operate at rates above the normal and produce an excellent and safe effluent. But the change in design was radical and took several years to develop. Also, as far as the writer is aware, the plant has only been used on water in the Far East.

The plant referred to is part of the water supply installation of the Singapore City Council Water Dept. and is under the control of the city water engineer, W. S. Stredwick, by whose permission the results are published. The writer was water engineer of the Singapore Municipality until April 1951.

F. G. HILL

Singapore, Malaya
Sep. 5, 1955

The Reading Meter

A Handbook on Cast Iron Pipes and Joints. *W. Boden. Stanton Ironworks Co., Near Nottingham, England (1954) 140 pp.; free*

British practice in the selection of spun and vertically cast iron pipe and appurtenances is outlined in this handbook. It contains an extensive and well illustrated section on joints. Not offered for sale, copies may be obtained from the publisher by engineers actively interested.

How Zinc Controls Corrosion. *American Zinc Institute, 60 E. 42nd St., New York 17, N.Y. (1955) 32 pp.; paperbound; free*

This extensively illustrated brochure describes the benefits of zinc paints and coatings, sherardizing, metallizing, and galvanizing as means of combating corrosion. The use of zinc anodes for cathodic protection is also discussed.

Bibliographic Survey of Corrosion, 1950–1951. *Publication 55-4, National Assn. of Corrosion Engineers, 1061 M&M Bldg., Houston 2, Tex. (1955) 435 pp.; $12.50*

The fourth in a series, this survey summarizes 4,454 articles on corrosion and corrosion prevention from more than 500 sources throughout the world. Abstracts are arranged topically, in accordance with the NACE indexing system. Subject and author indexes are appended.

ASA B31.1.8–1955—American Standard Gas Transmission and Distribution Piping Systems. *American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y. (1955) 101 pp.; $2.50*

This standard, approved Mar. 11, 1955, by American Standards Assn., is a revision of the 1952 edition of Section 8 of the American Standard Code for Pressure Piping (ASA B31.1).

NFPA 29C—Standard Specifications for Fire Hydrants for Private Fire Service. *National Fire Protection Assn., Boston, Mass. (1955) 16 pp.; $0.25*

Adopted in May 1955, the changes from the 1954 edition are largely editorial in nature. Materials, design, painting, marking, testing, and inspection are some of the subjects covered. In preparing this document, consideration was given to relevant AWWA specifications.

Lake Champlain Drainage Basin. *(1954) 195 pp.*

Susquehanna River Drainage Basin. *(1954) 325 pp.*

Chemung River Drainage Basin Series: *Report No. 1—Newtown Creek Drainage Basin. (1955) 43 pp.*

Oswego River Drainage Basin Series: *Report No. 2—Skaneateles Creek Drainage Basin. (1955) 51 pp. Recommended Classifications and Assignments of Standards of Quality and Purity for Designated Waters of New York State. Water Pollution Control Board, New York State Dept. of Health, Albany 1, N.Y.; paperbound; free*

The above are four more reports on New York State drainage basins. In addition to recommended classifications, these reports include the results (in tables and graphs) of stream flow and quality studies in the basins concerned.

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Index of Abstracts

Page numbers refer to P&R section of Journal. Letters immediately preceding page numbers refer to month of issue, using following key: Ja—January; F—February; Mr—March; Ap—April; My—May; Je—June; Jl—July; Au—August; S—September; Oc—October; N—November. All subjects and page numbers in boldface type indicate first pages of topic sections.

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Authors of Abstracted Articles

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Section Meetings

Missouri Section: The annual meeting of the Missouri Section was held at the Connor Hotel, Joplin, Sep. 25–27, 1955. There were 230 members and guests present. AWWA Vice-President Paul Weir gave a very interesting and informative talk titled, "The Water Works, Pace Setter of Progress." He outlined very effectively the value of the Association to the water works industry. Mr. Weir's comments were supported by a very excellent paper that followed—"How to Build Good Public Relations," by Robert L. Willier. The author, a public relations consultant, described in a very professional manner the mechanics for securing and maintaining good public relations.

Soil mechanics, a somewhat unusual topic for a water works program, was discussed by Henry M. Reitz, professor of civil engineering, Washington University, St. Louis. Mr. Reitz described the characteristics of soil which affect building foundations.

A great part of the program was given over to the discussion of water pollution

(Continued on page 80 P&R)

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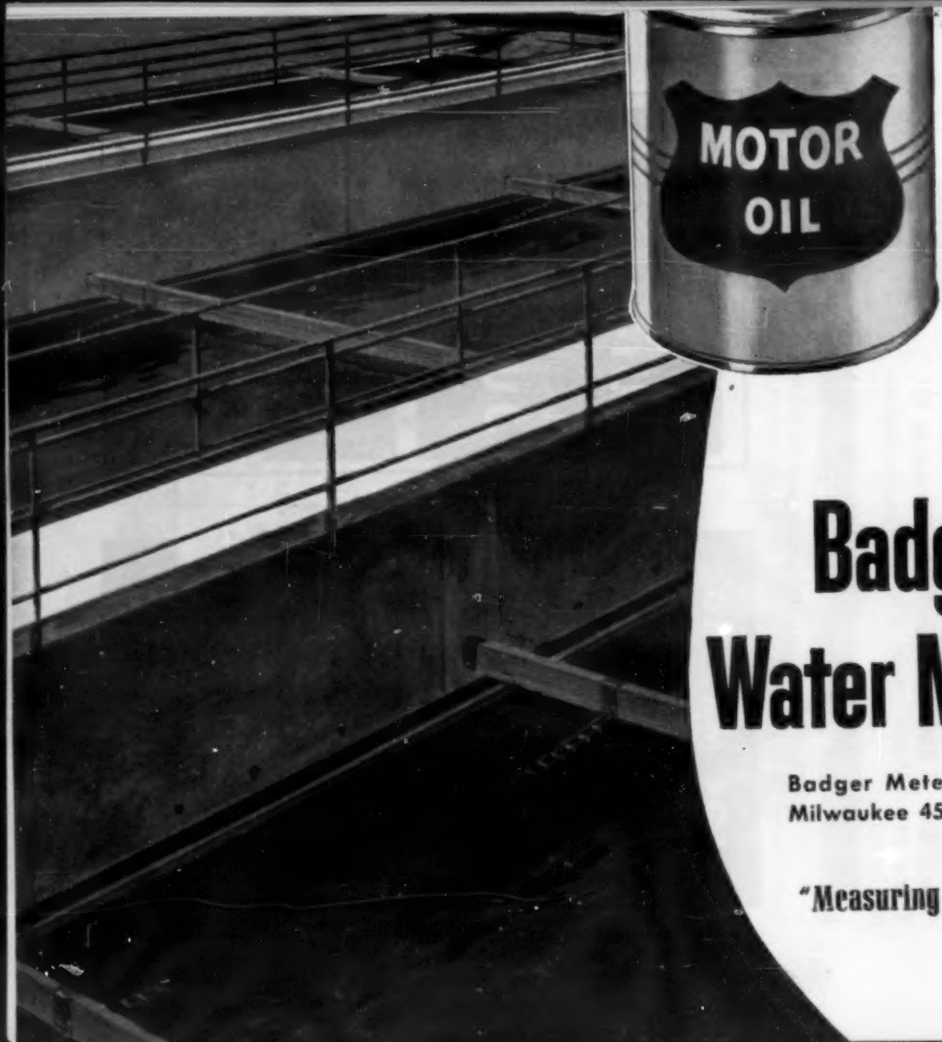
MOTOR
OIL

Section Meetings

(*Continued from page 76 P&R*)

control and its effect on water and sewage utilities. Bills to control water pollution in Missouri have failed to meet approval in the past two legislative assemblies. A resolution was passed at the meeting which provides for the Missouri Section of AWWA and the Missouri Water and Sewerage Conference to sponsor a bill in the next legislative general assembly. It is planned to set up a central committee to prepare a bill and organize subcommittees throughout the state to enlist public support for the passage of the bill.

"Plastics, Their Importance and Their Limitations in Water Treatment Plants"; "The Proper Tools for the Distribution System"; "Choosing the Proper Valve for the Job"; "The Membrane Filter"; and "The Effect of Detergents on Chemical Treatment of Water" were other topics of discussion.

The annual banquet was attended by 137 members and guests. The nominee for the Fuller Award was Frank E. Dolson, of the St. Louis County Water Co. The Missouri Section Tenure of Service Citation was presented to Cooper H. Allen, McWane Cast Iron Pipe Co.; James B. Bronson, general manager, Rolla Municipal Utilities; Roger C. Higgins, Board of Public Works, Hannibal; and Warren A. Kramer, chief, Water Supply, Missouri Div. of Health. Vice-President Weir presented Robert L. Baldwin, Burns & McDonnell Engineering Co., Kansas City, with a Life Membership certificate. The banquet was concluded by an address titled "The Plow, the Cross, and the Musket," given by F. Gano Chance, president, A. B. Chance Co., Centralia.

WARREN A. KRAMER
Secretary-Treasurer

Rocky Mountain Section: The 29th annual meeting of the Rocky Mountain

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Section Meetings

(Continued from page 80 P&R)

Section was held at Laramie, Wyo., Sep. 20–21, 1955. The total registration was 94. The sessions were held at the Elks Club, with above-normal attendance for the number registered. The program committee, under Chairman J. Orville Jones of Pueblo, Colo., had prepared an excellent program of subjects interesting to Section members. As usual, the water works meeting was preceded by a one-day sewage works meeting.

Tuesday morning was mostly devoted to registration. Sessions opened at 10 AM with a welcoming address by Carroll H. Mohr, mayor of Laramie. Chairman Eaton responded and appointed his committees. A motion picture, "Advanced Techniques of Bacteriological Water Analysis," was shown.

Tuesday afternoon sessions were devoted to technical papers. A report on underground water control and legislation was given by George Bady, chairman, Colorado Conservation Board. Frank Mascitti, of Minneapolis-Honeywell, gave a most informative talk, with slide diagrams, on instrumentation in water treatment plants. The importance of auxiliary water supplies was discussed by William Turney, consulting engineer, Santa Fe.

On Tuesday Mrs. Jack Hull was hostess at a luncheon for the ladies at the Connor Hotel. Card games, at which attractive prizes were awarded, followed.

On Wednesday the program opened with a panel discussion on pipe specifications. Participating were William Freeman, Lock Joint Pipe Co.; James B. Hill, American Cast Iron Pipe Co.; Mark Davidson, Thompson Pipe & Steel Co.; and Jack Davis, Johns-Manville. Next on the program was a film, "Water—Wealth or Worry for America." Closing the morning session, V. A. Vaseen, of Ripple & Howe, Cons. Engrs., Denver, discussed the importance of future plan-

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Section Meetings

(Continued from page 82 P&R)

ning, the use of a master survey plan, and finance forecasting.

The business luncheon was held in the main diningroom of the Connor Hotel, with 60 attending. Just prior to the luncheon the entire attendance was greatly shocked and saddened by the unexpected death, due to a heart attack, of Mrs. Harry Barnes, wife of the newly elected vice-chairman. The business luncheon was opened with a silent prayer for Mrs. Barnes and an agreement by all members to cancel the evening dancing.

During the luncheon the following members were elected to office: chairman—J. Orville Jones, Pueblo; vice-chairman—Harry Barnes, Rocky Ford, Colo.; secretary-treasurer—Jack Davis, Denver. Elected trustees for 3-year terms were R. G. Chenoweth, Worland, Wyo., and Jay Spencer, Denver. Elected to fill unexpired terms were Jack Maguire, Derby, Colo., and Ernest Martinez, Taos, N.M.

The program Wednesday afternoon was opened with a talk on "Problems Involved in Supplying Water to Subdivisions and Sanitary Districts," by Roy Sherrard, Cheyenne, Wyo., with comments by Arthur Williamson, also of Cheyenne. A paper prepared by William Gahr, Colorado state sanitary engineer, was read by Bob Lowe of Santa Fe. The subject was "Relation of Industrial Waste to the Cost of Water Treatment." The meeting was closed by a panel discussion of various water works problems, including safety and rates, led by Chairman Eaton.

Wednesday evening a banquet was held in the Elks Club. The newly elected officers were introduced by Chairman Eaton. Life Memberships were presented to D. D. Gross, Denver Water Board (retired), and Dana E. Kepner, Denver. Entertainment was furnished by male and female quartets.

The meeting, though highly successful, was saddened by the death of Mrs. Barnes, whom all will miss at future meetings.

JACK W. DAVIS
Secretary-Treasurer

CHANGES IN MEMBERSHIP

NEW MEMBERS

Applications received Oct. 1–31, 1955

Adamson, M. H.; *see* Malibu (Calif.) Water Co.

Amato, Jacob J., Atty., 331 Huey P. Long Ave., Gretna, La. (Oct. '55) *M*

Anderson, Harris Alfred, Engr., L. W. Burdick, 316 Cambridge St., Grand Forks, N.D. (Oct. '55) *MRPD*

Axtell, A. E.; *see* Glenwood Springs (Colo.)

Bailey, Louis G., Safety Engr., Dept. of Water Supply, 735 Randolph St., Detroit 26, Mich. (Oct. '55)

Beam, Raymond E., Chemist, Water Div., Sacramento, Calif. (Oct. '55) *P*

Bentley, Raymond C., Water Supt., Burleson, Tex. (Oct. '55) *MRP*

Bookwalter, W. F., Vice-Pres., Boyd E. Phelps, Inc., 1000 Washington St., Michigan City, Ind. (Oct. '55) *P*

Bowdry, W. P., Jr., Foundry Exec., Dallas Foundry Inc., Box 333, Dallas 21, Tex. (Oct. '55)

Bowman, Donald R., San. Engr., Montgomery County San. Dept., 127 N. Perry St., Dayton, Ohio (Oct. '55) *M*

Boyer, Max R., Water Treating Engr., Phillips Petroleum Co., Kansas City, Kan. (Oct. '55) *RP*

Bradakis, Henry L., Engr., Clyde E. Williams & Assocs., 312 W. Colfax Ave., South Bend, Ind. (Oct. '55) *P*

Branch, Linwood O. B., Jr., Sales Engr., A. P. Smith Mfg. Co., 512—22nd St., Virginia Beach, Va. (Oct. '55) *D*

Breaux, Albert, Gen. Mgr., Jefferson County Water Control & Irrigation Dist. No. 5, Box 68, Port Acres, Tex. (Affil. Oct. '55)

Brendel, W. B., Chief Engr., Bedell Bldg., 118 Broadway, San Antonio, Tex. (Oct. '55)

Brucks, A. J., Pres., Converse Water Co., Converse, Tex. (Oct. '55)

Burton, James E., Director, West Coast Labs., Culligan, Inc., State St. & Cajon Dr., San Bernardino, Calif. (Oct. '55) *RP*

Camel, Blaise G., Board Member, East Jefferson Water Works, 503 Lake Ave., Metairie, La. (Oct. '55)

Carmichael Irrigation Dist., Francis R. Ford, Gen. Mgr., Box 1, Carmichael, Calif. (Corp. M. Oct. '55) *MD*

Caughman, Clyde, Distr. Supt., General Waterworks Corp., Pine Bluff, Ark. (Oct. '55) *M*

Chappell, Clifton, Secy.-Mgr., Cucamonga Water Co., 9641 San Bernardino Rd., Box 635, Cucamonga, Calif. (Oct. '55) *MRPD*

Clark, Ernest R., Supt., Water Dept., 19 Dwight Rd., Burlingame, Calif. (Oct. '55)

Clemens, Jack W., Public Health Engr., Region No. 5, State Dept. of Health, Des Moines 19, Iowa (Oct. '55)

Cloyd, Robert W., Water Com., Box 247, Rogersville, Tenn. (Oct. '55) *P*

Coldiron, R. P., Supt. of Filtration, Water Works, Danville, Ky. (Oct. '55) *P*

Collins, O. A., Supt. of Distr., Water Dept., 2016 Prairie Ave., Forth Worth 6, Tex. (Oct. '55) *M*

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Cousins, Robert P., Sales Engr., Sparling Meter Co., 101 Park Ave., New York 17, N.Y. (Oct. '55) *MRPD*

Coyne, Glenn, Supt., Water Works, Dilley, Tex. (Oct. '55) *MP*

Cross, C. L., Foreman, Water Dept., Alexandria, La. (Oct. '55) *M*

Cunningham, A. W., Salesman, West Virginia Pulp & Paper Co., Indus. Chem. Sales Div., 230 Park Ave., New York 17, N.Y. (Oct. '55) *P*

Curran, Edward J., Jr.; *see* Fruit Growers Lab.

Dahlin, Paul Linden, Salesman, Darling Valve & Mfg. Co., 10855 S. Forest Ave., Chicago 28, Ill. (Oct. '55)

Dawkins, M. E., San. Engr., Reynolds, Smith & Hills, Box 4817, Jacksonville 1, Fla. (Oct. '55)

de Geurin, Pirtle J., City Engr., Box 209, Kerrville, Tex. (Oct. '55) *MRP*

DeHaven, James C.; *see* Rand Corp., The

Devitt, William Grey, Assoc. Engr., Div. of Water, City Hall, Fresno, Calif. (Oct. '55) *MRPD*

Donaghy, Norman H. C., Town Engr., Munic. Dist. of Yellowknife, Box 536, Yellowknife, Northwest Territories (Oct. '55) *MP*

Dorsey, Arthur E., Salesman, Solvay Chem. Div., Allied Chemical & Dye Corp., 1609 S. 6th St., Terre Haute, Ind.

Douglas, William C., Salesman, J. B. Clow & Sons, 824 Sherland Bldg., South Bend, Ind. (Oct. '55) *D*

Drown, Ralph D., Assoc. San. Engr., State Dept. of Public Health, Bureau of San. Eng., 631 J St., Sacramento 14, Calif. (Oct. '55) *P*

Drudy, Joseph E., Office Mgr., West Virginia Pulp & Paper Co., Indus. Chem. Sales Div., 230 Park Ave., New York 17, N.Y. (Oct. '55) *P*

Dunkirk, George L., City Engr., 30 Gerald Ave., Highland Park 3, Mich. (Oct. '55) *PD*

Dunn, William G., Cons. Engr., 439 Fairmont Ave., Mountain View, Calif. (Oct. '55) *R*

Eastland County Water Supply Dist. Inc., J. W. White, Plant Supt., Rte. 1, Ranger, Tex. (Corp. M. Oct. '55)

Edris, John P., Mgr., Water Utilities Inc., Stop 24 Long Beach, Michigan City, Ind. (Oct. '55) *MP*

Edwards, Roland L., Engr., The Jennings-Lawrence Co., 1392 King Ave., Columbus, Ohio (Oct. '55) *RPD*

Eldridge, Albert M., Supervising Engr., City of Austin, 5900 Bull Creek Rd., Austin 5, Tex. (Oct. '55) *MRP*

Eschavez, Honorato S., Public Health Engr., State Dept. of Health, 2411 N. Charles St., Baltimore 18, Md. (Oct. '55) *MRP*

Esser, John A., Mgr., First Utility Dist. of Hawkins County, Church Hill, Tenn. (Oct. '55)

Faires, Alton M., Sales Repr., Olin Mathieson Chem. Corp., 7306 Vernon Rd., Richmond 28, Va. (Oct. '55) *P*

Feagan, George H., Engr., Homer A. Hunter Assocs., 3708 Abrams Rd., Dallas 14, Tex. (Oct. '55) *M*

Ferrel, George F., Director of Public Works, Plattsburg, Mo. (Oct. '55) *MPD*

Finlay, Ray F., Sales Mgr., American Plastic Pipe Corp., 16616 Garfield Ave., Paramount, Calif. (Oct. '55) *D*

Ford, Francis B.; *see* Carmichael (Calif.) Irrigation Dist.

Fruit Growers Lab., Inc. Edward J. Curran, Jr., Mgr., 132 N. 4th St., Santa Paula, Calif. (Corp. M. Oct. '55) *RP*

Fuhrmann, Walter O., Supt., Water & Sewer Dept., Box 526, Fredericksburg, Tex. (Oct. '55) *M*

Gaffin, Harry A., Chief Engr., A. P. Smith Mfg. Co., 545 N. Arlington Ave., East Orange, N.J. (Oct. '55) *D*

Gallaher, John J., Field Repr., Dresser Mfg. Div., 1121 Rothwell St., Houston, Tex. (Oct. '55) *M*

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Gamble, J. F., Supt. of Filtration, Water Dept., Shelby, N.C. (Oct. '55) *P*

Glenwood Springs, City of, A. E. Axtell, City Mgr., City Hall, Glenwood Springs, Colo. (Corp. M. Oct. '55) *RPD*

Goetz, F. M., Salesman, Cal-Metal Corp., Box 338, Torrance, Calif. (Oct. '55) *M*

Gould, Lloyd M., Foreman, Fridley Softening Plant, 43rd & Marshall St. N.E., Minneapolis 21, Minn. (Oct. '55) *MRPD*

Granados, Juan A., Engr., Radiocentro 716, Vedado, Havana, Cuba (Oct. '55)

Griffin, Ralph G., Jr., Engr., Industrial Hygiene Sec., Div. of San. Eng., State Dept. of Health, Austin, Tex. (Oct. '55) *P*

Hanauer, J. B.; *see* Hanauer, J. B., & Co.

Hanauer, J. B., & Co., J. B. Hanauer, 140 S. Beverly Dr., Beverly Hills, Calif. (Corp. M. Oct. '55) *MRPD*

Harlos, Harold H., Master Electrician, Water Board, 2001 Sacramento St., San Antonio 1, Tex. (Oct. '55) *M*

Harper, George E.; *see* Pinedale County (Calif.) Water Dist.

Harrington, Tom, Secy.-Mgr., San Dieguito Irrigation Dist., 669—2nd St., Encinitas, Calif. (Oct. '55) *MD*

Harris, Thomas B., Chief, Water & Sewage Branch, Utility Div., Post Engr., Fort Sam Houston, Tex. (Oct. '55) *MR*

Healy, Gerald D., Jr., Public Health Engr., State Dept. of Health, Civil Courts Bldg., New Orleans, La. (Oct. '55) *MRP*

Hindman, Clifford R., Engr., Burgess & Niple, 2015 W. 5th Ave., Columbus, Ohio (Oct. '55) *P*

Hodge, W. F., Mgr., Consumer Accounts, Water Dept., Box 2478, Raleigh, N.C. (Oct. '55) *M*

Hodgson, Kenneth O., Sales Repr., Ludlow Valve Mfg. Co., Inc., 7 S. Dearborn St., Chicago 3, Ill. (Oct. '55)

Holcombe, E. W., Jr., Supt., Water & Sewage, Box 332, Marion, Ala. (Oct. '55)

Hoobler, George, Supt. of Public Works, Spencerport, N.Y. (Oct. '55) *MRD*

Horsfall, Charles W., Mgr., Westport Branch, Bridgeport Hydraulic Co., 61 E. State St., Westport, Conn. (Oct. '55)

Humboldt Community Services Dist., Ernest A. McFarland, Pres., Board of Directors, Box 207, 5055 Walnut St., Cutten, Calif. (Corp. M. Oct. '55) *MRPD*

Indian Head Water Co., Inc., The, Joseph Strassner, Vice-Pres., Jericho Turnpike, Commack, N.Y. (Corp. M. Oct. '55) *MRPD*

Johnson, Donald Allen, Mgr., Pump Sales Dept., Fairbanks, Morse & Co., 220 E. 5th St., St. Paul 1, Minn. (Oct. '55)

Johnston, Marvin L., Chief Accountant, City of Fresno, 2326 Fresno St., Fresno, Calif. (Oct. '55) *M*

Karoly, Bennett T., Asst. San. Engr., State Dept. of Public Health, Bureau of San. Eng., 631 J St., Sacramento 14, Calif. (Oct. '55)

Kelley, W. D., Cons. Engr., Kelley, Gidley & Staub, 5418 MacCorkle Ave., S.W., Charleston 3, W.Va. (Oct. '55)

Kersten, William W., Graduate Student, San. Engr., Univ. of Iowa, Iowa City, Iowa (Jr. M. Oct. '55) *P*

Ketchikan Public Utilities, Elmer B. Titus, Mgr., Box 1019, Ketchikan, Alaska (Munic. Sv. Sub. Oct. '55) *MPD*

Kim, Kyung Lin, Chief, Water Works Sub-sec., Bureau of Public Works, Ministry of Home Affairs of Republic of Korea, Garit, Seoul, Korea (Oct. '55) *MRPD*

Kutsch, Richard H., Dist. Mgr., Fischer & Porter Co., 823 Professional Bldg., Charlotte, N.C. (Oct. '55) *P*

Lehner, Walter J., Partner, Walter J. Lehner & Sons, 204 Lawyers Bldg., Mount Clemens, Mich. (Oct. '55) *P*

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Linda County Water Dist., Harold R. Lowe, Supt., Rte. 1, Box 2340, Marysville, Calif. (Munic. Sv. Sub. Oct. '55) *MD*

Lloyd, Abbott E., Jr., Asst. to Engrs., Water & Sewer Dept., Durham, N.C. (Oct. '55)

Love, Fred G., Asst. Mgr., Harris County Water Control & Irrigation Dist. No. 24, Box 3297, Bellaire, Tex. (Oct. '55) *MRP*

Lowe, Harold R.; *see* Linda County (Calif.) Water Dist.

Luckett, D. S., Foreman, Water Dept., 1806 Elliott, Alexandria, La. (Oct. '55) *M*

Mace, Robert C., City Engr. & Water Supt., Box 416, Breckenridge, Tex. (Oct. '55) *MRP*

Male, C. T., Assocs., Kenneth J. Male, Engr., 3010 Troy Rd., Schenectady 9, N.Y. (Corp. M. Oct. '55) *D*

Male, Kenneth J.; *see* Male, C. T., Assocs.

Malibu Water Co., M. H. Adamson, Pres., 22821 Pacific Coast Hwy., Malibu, Calif. (Corp. M. Oct. '55)

Matthern, Robert O., Graduate Student, Purdue Univ., Lafayette, Ind. (Oct. '55) *PD*

McFarland, Ernest A.; *see* Humboldt Communitiy Services Dist.

McKee, M. B., M. B. McKee Co., 2205 Ave. E, Lubbock, Tex. (Oct. '55)

McNutt, Everett L., Supt., Water Dept., 3345 S. Bannock, Englewood, Colo. (Oct. '55) *PD*

McQuade, Richard A., Mgr., Munic. Div., Penn Instruments Div., Burgess Manning Co., 4110 Haverford Ave., Philadelphia 4, Pa. (Oct. '55) *MPD*

Meadows, J. A., Supt., Water Works, Del Rio, Tex. (Oct. '55) *M*

Meyer, Werner H., Salesman, San Antonio Machine & Supply Co., Box 224, Fredericksburg, Tex. (Oct. '55) *M*

Miller, Milton S., Sales Repr., James Lithgow Co., 1313 W. Sepulveda Blvd., Torrance, Calif. (Oct. '55) *MD*

Millspaugh, D. V., Supt., Water Dept., 712 S. 7th St., Clinton, Okla. (Oct. '55)

Monroe, Paul H., Engr., Water Dept., Rm. 319, City Hall, Pasadena, Calif. (Oct. '55) *RD*

Moulton, James S., Vice-Pres. & Exec. Engr., Pacific Gas & Elec. Co., 245 Market St., San Francisco 6, Calif. (Oct. '55) *MRPD*

Mount, Harold F., Gen. Mgr., Preston Street Road Water Dist. No. 1 & Louisville Extension Water Dist., 4722 Preston Hwy., Louisville, Ky. (Oct. '55) *M*

Newman, E. Clive, Graduate Student, Civ. Eng. Dept., Colorado A & M College, Fort Collins, Colo. (Jr. M. Oct. '55) *R*

Nielsen, H. Eugene, Cons. Engr., Nielsen, Reeve & Maxwell, Inc., 2843 N. 700 E., Ogden, Utah (Oct. '55) *RP*

O'Brien, O. E., Water Supt., Catulla, Tex. (Oct. '55)

Pinedale County Water Dist., George E. Harper, Pres., Board of Directors, Box 629, Pinedale, Calif. (Munic. Sv. Sub. Oct. '55) *M*

Rand Corp., The, James C. DeHaven, Asst. to the Director, 1700 Main St., Santa Monica, Calif. (Corp. M. Oct. '55) *R*

Reid, J. D., City Engr., City Hall, North Bay, Ont. (Oct. '55)

Rhoades, Robert H., Lab. Technician, Water & Sewers Div., 827 E. Jefferson St., Phoenix, Ariz. (Oct. '55) *MRPD*

Rice, Gilbert, Operator, Indiana Southern Corp., Rockport, Ind. (Oct. '55) *D*

Sanders, Robert N., San. Engr., Bureau of San. Eng., State Board of Health, Little Rock, Ark. (Oct. '55) *MPD*

Scherer, James, Repr., Indiana Southern Corp., Rockport, Ind. (Oct. '55) *MD*

Strassner, Joseph; *see* Indian Head Water Co., The

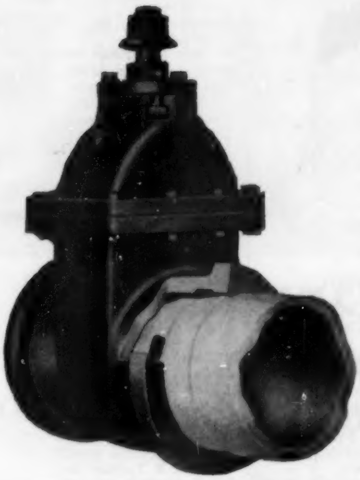
Titus, Elmer B.; *see* Ketchikan (Alaska) Public Utilities

White, J. W.; *see* Eastland County (Tex.) Water Supply Dist.

Index of Advertisers' Products

Now Ring-Tite Joints

for RENSSELAER VALVES



Rensselaer Valve Co. in cooperation with Johns-Manville has adapted Gate Valves and Hydrants to the Ring-Tite Joint, developed by Johns-Manville for Transite Pipe. The first experimental installation of Ring-Tite valves was made in July 1953 at Mattapoisett, Massachusetts.

FAST AND SURE INSTALLATION

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Rensselaer Valve with "O" Ring Seal and Ring-Tite Joint.

At low pressures, the seal is obtained by radial compression of rubber rings. At higher pressures, rings are wedged in the grooves tighter by the pressure.

Rensselaer Gate Valves with Ring-Tite Ends are available in sizes 4" through 12" for Class 150 Transite Pipe.

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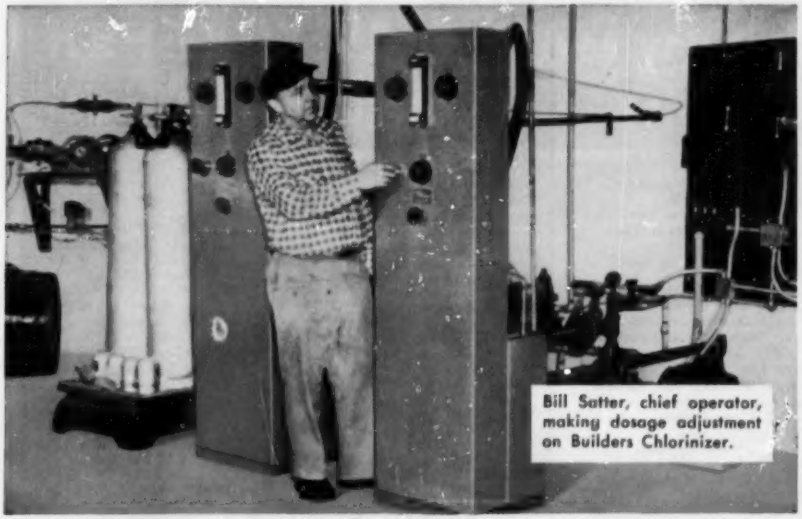

Bill Satter, chief operator, making dosage adjustment on Builders Chlorinizer.

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Grand Haven (population 10,000) gets its municipal water from three Ranney type wells located just off the shore in Lake Michigan. Water drawn from these wells is chlorinated by two Model DVS-A Builders Chlorinizers, and then pumped directly into the main which supplies the city.

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Zeolite; see Ion Exchange Materials

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